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NORTH POLAR RIFTS AND ARCTIC CANALS ON MARS.

PERCIVAL LOWELL.

FOR POPULAR ASTRONOMY.

One of the results obtained from the study of the planet at Flagstaff during the opposition which has just passed has been the identification of the rifts in the north polar cap with canals in the arctic regions.

Rifts in the ice-cap are of recent detection. How recent may be gathered from the fact that no mention is made of them in Flammarion's thesaurus of observations on the planet published in 1892, a very scholarly and complete account of the state of our knowledge of the subject up to that time. One rift had indeed been noticed before this, a rift detected in the north polar cap in 1884 by Schiaparelli, but his memoir upon it had not then been published. The next one to be seen was detected that very year, 1892, by W. H. Pickering in the south cap; a re-observation of which in 1894, at Flagstaff, was followed by the discovery of several more during the breaking up of that cap. In February 1896 a dark line showed in the north polar cap which at the time of the observatian I believed to be the first ever seen in that cap; but the next day on taking up Schiaparelli's memoir on the opposition of 1884, which had recently arrived, I opened upon a drawing of this very rift. So long a time does it take astronomical observations to get published! To get generally known, if one may judge by the text-books, involves a period measured rather by eternity than time. What I shall offer here may be, therefore, called proof before letter as it refers to observations made at the opposition just past.

During the opposition of 1900-1 the north polar cap of the planet, a snow-sheet which at its maximum covered from 65° to 70° of longitude, was very favorably placed for terrestrial observation at just the season affected by rifts. The season for rifts is from six to ten weeks after the vernal equinox.

Up to the end of the old year observation of the polar cap had revealed nothing but an immense unbroken field of white. The season on Mars was then what corresponds to May 7th on the Earth. The cap was already in process of melting but such melting had been confined to its outer edges. It had in this manner shrunk some seven or eight degrees all around from its extreme outposts of a month and a half before. On the first day of the new year Mr. Douglass detected a rift in it. The rift was a difficult object, so hard to make out that he was not absolutely sure of it at first. The next few weeks, however, showed that he had probably not been deceived. For as other longitudes were presented to view by the rotation of the planet other rifts were revealed less mistakably. One of the most striking ran from the large longitudes east and west with a southward trend until it reached longitude 30° when it turned abruptly upward and came out at the edge of the cap. Its position marked it for the same rift which had appeared to Schiaparelli in 1884 and later to me in 1896. Identity in locality corroborated what I had inferred in 1894 and 1896 about the rifts, viz: that they were permanent in place. Recognition of this had certainly been an important fact, but like every step forward in science it had brought new problems into view.

If the rifts were fortuitous phenomena they required no particular explanation. Lack of local habitation meant that the cap rested upon practically level ground and its melting in one spot rather than in another might be due to local variations of climate from year to year just as we have cold winters in America coincident with warm ones in Europe or vice versa. The moment it was recognized that the spots where disintegration advanced beyond that of its neighbors were always the same, it became clear that the character of the ground lay at the bottom of the transformation. The rifts were places where the locale for some reason or other favored an early disappearance of snow. The question then arose, what would favor such a state of things, and is a matter of physics and natural history. On Earth a large body of water might account for it, or a lower tract of country. But bodies of water are excluded in the case of Mars: first, by the impossibility that bodies of water of sufficient shallowness to evaporate completely in summer should be solidly frozen during the long Martian winter, and secondly, by the more obvious fact that long and slender lines such as the rifts showed themselves to be, cannot, by virtue of their appearance, be oceans or seas. Thought turns, therefore, to solid

ground for an explanation. Here it stands confronted by an equal difficulty. If a lower level were responsible for the phenomenon, this would mean, in the case of Mars, a very considerable depression, much greater than it would mean on the Earth. For to produce a difference in temperature of one degree a much greater height is necessary there than here. So much follows at once from the less mass of that planet. Warmth at varying altitudes on the surface of the Earth depends, other things being equal, on the density of the air due to greater or less height above sea-level. The air simply acts the part of a blanket and the lower parts of the Earth's surface being the most provided with clothes, are the warmest. A cooling which a mile of ascent would bring about on Earth, would take nearly three miles of travel skyward to accomplish on Mars, and similarly downward, for warmth. If, then, the melting along the rifts was due to the initial depth of these depressions they must needs be immense chasms like those which the streets of our great cities are soon to become. If so, they could hardly fail to accumulate huge glaciers during the long arctic winter night. Instead, therefore, of being the first places to melt, they would infallibly be the last. Difference of elevation, then, viewed as an explanation, breaks down when closely scanned. I pondered over this in the past and finally gave the problem up as insoluble.

At this point in our ignorance of what the rifts were, the observations upon them in January 1901 were made. Their entrances and exits upon the stage of the planet's history were carefully chronicled, and duly recorded in as accurate drawings as it was possible for Mr. Douglass to construct. Then the page was turned and they were left to slumber between the sheets till the day of their publishing resurrection. Meanwhile the rest of the snow was busy melting and before long the rift itself had ceased to be. Persistent only as nature is persistent in subsequent reproduction, it was destined to reappear in situ among the snows of another spring.

By the beginning of April—our April that is—it was then the Martian 17th of June, the cap had been reduced to practically its lowest terms. But in spite of this dearth of snow the arctic regions were not well seen. There was something still in the way. Surrounding the cap itself on all sides lay a broad collar of pale white as unlike the cap on the one side as it was different from the bright general ground work of the disk on the other. It had none of the sheen of the snow-cap, but rather that dull pearly appearance one sees in clouds. It did not move, remain-

ing where it was for the space of a fortnight or more. Then it disappeared. In view of what was going on in the snow-cap at the time it is no far conjecture to see in this collar a great mist bank due to the rapid evaporation of the cap. On a large scale it was undoubtedly a spring haze such as on a smaller one we are familiar with on any warm spring day, and which to a more comparable degree, causes the summer fogs off the banks.

By May—July 1st on the planet—this too had gone, or largely so, for though the arctic detail began to come out, it was not as clear or as omnipresent as one could wish. This was a fact which corroborated the previous deduction that there was much mist in this part of the Martian air. In June whatever it was had cleared away and the arctic regions showed better than they had at either of the two previous presentations, in spite of the fact that the planet had greatly increased its distance from the Earth in the interval, and the diameter its disk subtended had diminished from 11″.5 to 7″. Decrease of diameter was a boon in disguise. It increased the difficulty of detection, but at the same time, the certainty of comparison. Increased clearness of detail with increased distance showed that the clearness lay not in the distance, an important factor to eliminate. By the 9th of June—July 20 on the planet—the arctic skies had cleared and let us look down upon the actual surface of the planet. Several canals then became recognizable in the region about the pole, outside of the little space occupied by the cap. On comparing the drawings made of them with those made in January by Mr. Douglass of the same region—at that time buried beneath the snow—I perceived that the position of the great rift in his drawings of the 19th of that month was now held by an equally long and important canal. The identity of position was sponsored of the Mare Acidalium and the Callirhoe which appeared in both drawings, while the shorter turn the rift had made to the left to meet the edge of the cap was now represented by another canal. The new canal, like the rift of which it was the apotheosis stood by the side of the Callirhoe, parallel with it, only much to the north.

Pursuing the subject, I found that this, though the most striking, was not the only instance of rift-canal identification. A little after the appearance of the rifts first mentioned a short and more or less sturdy one had shown itself standing north and south in the cap and headed for the Arethusa Lake. When the Sun had cleared away the snow, a canal stood forth to sight where this rift had stood in February, to-wit, the canal called the Kison.

Similarly, I think, the list might be lengthened. However, the process of identification is not as simple as it sounds for the tilt of the arctic regions, even when most favorably placed, is against revelation, whether of rifts or canals, for two reasons. The inclination of the parts about the pole is not only such as to turn them away from sight, but to make a very small quantity denote a great angle of change. To add to the difficulty, the time at which the tilt is least disadvantageously directed is when the planet is at its more remote distances from the Earth. We thus have the questionable alternatives of seeing relatively better, a part of a whole seen absolutely worse, or, of seeing relatively worse, a part of a whole seen absolutely better. To this difficult dilemma we must attribute the lack hitherto to correlate the chrysalis state of the phenomenon with its imago—the rift with the canal; not to mention the trifling preface to that conclusion of not having been able to see either premises.

The fact, however, once seized, tells us something more about the rift. The rift has this self-evident characteristic that the snow melts off it before the like happens to the surrounding land. it also turns out to be a canal in embryo. It, therefore, has the general characteristics of the canals. Now all the knowledge we have been able to glean from their behavior, about the constitution of the canals, is that they are vegetation phenomena. They are seasonal in their habit and develop and disappear in the manner and at the time a flora would. The moment we look at the rifts in this light, the difficulty of interpretation vanishes at once. If there were strips of vegetation in the midst of the desert that underlies the polar cap, such vegetation would make its presence known by appearing as rifts in the snow-field. Such would be the case for the following reason. The life of plants has this in common with the life of animals, that their vital processes both generate heat. The fact was not recognized as true of plants until long after it was well known of animals. Indeed, the discovery that plants give out heat in growing is of comparatively recent detection. It is now, however, just as certainly known as that all animals, even the most cold blooded, do. Now mark what this entails. Plants can grow in the snow. Of so much we are cognizant on Earth. Once started growing in the snow they help themselves to yet further advance, for the heat evolved in growing, instead of being wasted on the surrounding air, melts the coverlid of snow about them and gives them greater scope for action. Once launched the process goes on in geometric progression. The launching is done by the simple ar-

rival of the proper time of year. This compels the initial step. The recurrent warmth of spring melts the frozen coverlid a little, sets free the water the vegetation needs, adds the fillip of a more genial temperature, and the plant feeling the favorable influence, responds and is quickened into life. After that it looks after itself.

If then the canals are vegetation, they should be first seen as rifts in the thawing polar cap. That the two, rift and canal, are one, gives therefore, explanation of the occurrence of rifts. It shows that no difference of level is needed to account for them, and it is no longer surprising that none is seen. The rifts offer no objection to the general theory that the planet's surface is remarkably flat. At first sight they seem to do so; at second sight to be inexplicable, and at third, to be quite in keeping after all with that supposition.

Reversely, the identity of rift with canal affords further ground for believing that the canals are vegetal, that they are floral phenomena; and the corroboration is of considerable cogency, since the test of the truth of a theory is even more evidenced by its capacity to explain facts arising subsequent to its enunciation than by its fitting the facts known at the time of its promulgation. It is fashioned to suit the one: it is quite independent of the other. We thus see that the identifying of rifts with canals is a more important matter than it would appear at first.

BOSTON, Mass.

CRITICISM BY DR. KLEIN OF WILLIAM H. PICKERING'S LUNAR OBSERVATIONS.

WILLIAM H. PICKERING.

FOR POPULAR ASTRONOMY.

I have been asked to make some statement with regard to the criticism of my lunar work (*Annals H. C. O.*, Vol. XXXII) which appeared in the February number of this journal. I feel however, in general that what Dr. Klein has said has been so appreciative and so exact, that there is very little in it to which I can take exception. Indeed to his remark that I was not as familiar as I might be with some of the earlier German literature on the subject, as contained in Gruithuison's publications, and the earlier numbers of the periodicals *Sirius* and *Wochenschrift*, I fear I must plead guilty.

There are a few statements, however, where I cannot entirely agree with him. For instance in the case of Plato, where I endeavored to show that craterlet 61, formerly conspicuous, had now entirely disappeared. Dr. Klein identifies 61 with my 62 which is very near it and which I saw distinctly although it was very minute. The objection to this explanation is that Stanley Williams in 1882-4 saw both 61 and 62, the former being at that time the eighth in visibility upon the floor, and the latter the forty-first. He describes them as a close pair. Craterlet 62 is now the twenty-eighth in order of visibility, and 61 is invisible.

Dr. Klein denies that the bright areas on the floor of Plato are liable to change, but their shapes are so readily distinguished, and the opinion of all astronomers who have observed them carefully is so unanimous in support of the changes, that I think it would be hard to maintain the contrary opinion against the large bulk of evidence that might be produced favorable to the supposed change.

With regard to the variable size of the white spot surrounding Linné, it is true as Dr. Klein says, that the change in size is not as conspicuous as that of the polar caps of Mars,—if it had been it would have been discovered long ago. Under favorable circumstances the latter vary from 15″ in diameter to nothing. The spot surrounding Linné varies from 4″ to 2″, the last figure representing its diameter one terrestrial day after lunar noon, and the former its diameter one and a half days after lunar sunrise. Other white spots on the Moon have also been found to vary in a similar manner. Although the changes are less conspicuous than those on Mars that seems to me to be no argument against their being genuine, as long as they are all of them distinctly visible.

What Dr. Klein says in regard to the colors visible in the region surrounding Aristarchus is very interesting. Although very familiar with the region in question, I had never noticed the green color. I have looked for it recently on two or three occasions with a six-inch telescope at about the time of full Moon, but unsuccessfully. If it is often as conspicuous as he says, it is certainly well worthy of further investigation. The violet I remember seeing once most conspicuously in Arequipa. I paid little attention to it however, as I attributed it to the secondary spectrum of the objective, visible owing to the intense brilliancy of Aristarchus itself. This explanation evidently occurred also to him and was rejected. To test the matter further I recently examined the Moon alternately with a six-inch refractor and a twenty-inch reflector, using in each case a power of about one

hundred diameters. In the refractor a dark area partly surrounded Aristarchus, its breadth being about equal to the semidiameter of the crater, and over this area a clearly marked violet shading was distinctly visible. In the reflector no coloring whatever of the region could be detected. I therefore believe all the coloring that I see in this region to be purely optical.

Although Dr. Klein rather unkindly remarks that all my observations on Messier were anticipated by Gruithuison seventy years ago, he still, I notice, devotes several pages to their discussion in the columns of *Sirius*, and states that he has never seen the two dark spots which cover a portion of their interiors, and to which I devoted considerable attention in my observations. Indeed it does not seem to me that the changes which I considered the most important were observed by Gruithuison at all. I refer especially to the constantly varying shapes of the two craters from one lunation to another, notably about the sixth day after sunrise, also to the varying shapes and sizes of the dark spots contained within them.

I am aware of the elevated ridge lying between Messier and *A* to which Dr. Klein refers, but do not think it is as high as the crater rims themselves, therefore on the whole I represented it as a depression with regard to them. My observations did not extend late enough in the lunation to show the shadow of *A* cast upon Messier.

With regard to the question of clouds, or more strictly speaking low mist or fog upon the Moon, I must say that I am still in doubt. Dr. Klein evidently believes in their existence in certain restricted areas. I think there is no question but that water vapor is given out by certain craterlets, and is transported and deposited on the surrounding regions in the form of hoar frost, but whether the vapor is solidified before reaching the surface, thus forming fog, or whether it remains gaseous and transparent in transit, being deposited the moment that it solidifies is another question. I formerly held the former, I am now rather inclined to the latter view, but perhaps both are correct.

In conclusion I may say that it is very gratifying to me that with a few trifling exceptions, so many of my views and observations should be corroborated by so eminent a selenographer as Dr. Klein.

HARVARD COLLEGE OBSERVATORY,
January 25, 1902.

THE REAL PATHS OF BRILLIANT METEORS.

W. F. DENNING.

For Popular Astronomy.

The following is a list of the real paths of some of the brighter meteors seen in England during the last five years. Many of the objects enumerated were recorded by Professor A. S. Herschel at Slough, Mr. H. Corder at Bridgwater, and by the writer at Bristol, but a great number of other persons also shared in the observations. Large meteors make their apparitions unexpectedly and are therefore frequently witnessed by casual observers upon whose descriptions it is sometimes imperative to rely in investigating the real paths. It is unfortunately the case however that the data furnished by non-practised observers are often both inaccurate and incomplete so that the results obtained from their discussion are only approximately correct. The majority of the objects included in the table were however recorded by persons more or less experienced in meteoric work and the deductions may be regarded as pretty reliable.

Brilliant meteors are comparatively numerous though not often well seen and exactly described and it is regrettable that very precise conclusions can seldom be arrived at concerning their particular orbits. It is certain that not one fireball out of every million which are visible forms the subject of satisfactory investigation. Professor Newton computed that the number of meteors which enter the Earth's atmosphere is 10,460 times the number visible at one station. If therefore several fireballs are annually observed in England (as we are justified in assuming from past experience) from a system such as the Scorpiids of June and July, it seems probable that there are tens of thousands of brilliant objects distributed every year from this stream alone over various parts of the world. It is rather a discouraging reflection that we are enabled to gather only very scanty materials from the vast array which nature supplies. Some consolation may however be found in the circumstance that the fall of a few drops of rain will sufficiently indicate the direction of the multitude forming a shower and so we may hope that the radiant points derived from the scanty number of fireballs suitably recorded fairly represent the shoals of similar bodies which elude proper observation. In fact even the stray and limited examples of fireballs which we have accumulated must afford us a good idea as to the heights, velocities and directions of their luminous descents

towards the Earth's surface and perhaps enable us to form a rough estimate as to the prolific host which infest planetary space and are individually liable to encounter the Earth's atmosphere where after a momentary blaze, their careers are termin-

REAL PATHS OF BRIGHT METEORS OBSERVED IN ENGLAND DURING THE FIVE YEARS 1897 TO 1901 INCLUSIVE.

Date.	G. M. T.	Magnitude.	Height at Beginning	Height at Ending	Length of Path	Velocity per sec.	Radiant Point.	Notes.	Observers.
	h m		miles	miles	miles	miles	alpha delta		
1900 June 9	2 55	F	59	23	174	R	280 − 12	In sunshine	10
1901 " 13	10 35	F	61	52	54	8	149 − 12	Very slow	3
1898 " 21	5 32	F	82	25	235	34	130 + 30	Long path	33
1901 " 28	9 18	2 × Venus	76	16	61	18	106 + 52	Detonated	4
" Feb. 13	10 41	Venus	56	26	36	M	72 + 41	γ Aurigid	2
1898 " 20	8 54½	F	61	27	95	24	176 + 12	Spark train	18
1901 " 27	8 52	F	130	57	120	S	165 − 6	Emitted sparks	3
1899 Mar. 1	7 0	4 × Venus	73	28	53	21	119 + 31	Flaming nucleus	2
" "	8 49	△ Venus	58	22	39	10	119 + 33	Three outbursts	4
1901 " 6	7 25	F	84	27	66	S	51 + 43	Burst into fragments	8
" Apr. 1	9 44½	F	69	12	67	S	129 + 25	Shower of sparks	7
1899 " 4	7 59	2 × Venus	60	52	160	S	202 − 10	Broke into pieces	3
1898 " 5	10 15	F	89	25	162	11	121 − 1	Well observed	5
1901 " 19	9 28	Venus	56	52	40	25	226 − 17	Bright streak	3
" " 21	10 8	♃	79	51	68	R	268 30	Lyrid	3
1897 " 30	9 38	5 × Venus	59	18	70	23	291 59	Spark train	7
1900 May 5	8 20	F	64	43	112	20	245 + 5	Reddish tail	15
1899 June 2	8 47	Venus	61	51	170	S	250 − 23	In twilight	3
1900 " 10	9 10	F	65	28	55	32	336 − 73	Broke into pieces	9
1901 July 8	11 37	♃	53	26	151	12	253 − 24	Tail of sparks	2
1900 " 15	10 13	2 × Venus	51	21	78	16	297 − 11	Broke into pieces	5
" " 17	8 47	F	58	51	175	S	249 − 20	Train 47 mins.	17
" " 19	11 49	♃	81	54	43	35	17 + 50	Perseid	2
" " 24	10 49	3 × Venus	68	27	103	19	280 − 15	Spark train	5
1898 " 26	9 10	½ = ☽	73	27	191	slow	269 − 23	" "	3
" " 30	10 43	♃	81	47	57	36	23 + 53	Perseid	2
1900 " "	10 45	F	95	50	92	R	30 + 52	"	5
1897 " "	8 47	3 × Venus	54	23	50	13	155 + 59	Shower of sparks	1
" Aug. 2	13 58	3 × Venus	81	47	59	36	312 ± 0	Streak	2

ated forever! The brilliant specimens which have been successfully observed in past years have no doubt been fairly typical of the whole of these attractive phenomena. In England the small

extent of country favors the multiple observation of identical meteors for one of these objects may be well seen simultaneously from large towns like London, Liverpool, Manchester, Birmingham, Leeds, Hull, Bradford, Bristol, etc. In America and on the

REAL PATHS OF BRIGHT METEORS OBSERVED IN ENGLAND DURING THE FIVE YEARS 1897 TO 1901 INCLUSIVE.—Continued.

Date.	G. M. T.	Magnitude.	Height at Beginning	Height at Ending	Length of Path	Velocity per sec.	Radiant Point.		Notes.	Observers.
	h m		miles	miles	miles	miles	alpha	delta		
1899 Nov. 10	10 14	Venus	76	40	54	R	41	+ 57	Perseid	4
1898 " 11	8 58	Venus	66	41	196	slow	339	− 10	Aquarid	12
" "	10 16	Venus	92	68	45	R	44	+ 56	Perseid	12
1901 " 11	11 2	2 × Venus	95	56	63	R	45	+ 58	"	5
" " 15	10 48	Venus	81	61	37	41	52	+ 53	"	2
1900 " 19	10 36	3 × Venus	56	29	62	S	346	= 0	See F's of Sept. 8 & 14	2
1901 " 20	11 14	2½	56	33	44	13	213	+ 49	Trail photographed	2
1898 " 21	9 16	1½ × Venus	60	29	95	19	5	+ 13	Green color	5
1899 " 24	8 11	F	77	27	118	17	345	+ 14	Red sparks	40
" " 27	10 13	∨ Venus	68	47	143	25	191	+ 32	Series of Flashes	6
" Sept. 2	12 5	3 × Venus	86	60	28	R	46	+ 42	Streak 1 min.	2
1900 " 5	6 54	F	85	20	84	S	334	+ 57	Train 35 min.	37
1899 " 4	8 13½	Venus	67	21	52	M	311	+ 79	Bright streak	2
" " 8	8 21	"	71	26	114	20	347	+ 3	Slight train	2
1901 " 14	8 45	"	66	26	83	20	345	+ 1	Spark train	20
1898 " 15	8 17	2½	69	61	58	39	65	+ 35	Bright streak	2
1900 " 16	8 44	2 × Venus	50	32	86	S	324	− 25	Nucleus pale green	4
1808 " 17	11 40¼	2½	95	64	93	R	57	+ 7	Streak	2
1899 Oct. 2	8 24	Venus	67	45	88	13	284	− 47	Double nucleus	5
1900 " 21	8 35	F	68	20	66	11	300	+ 22	Very brilliant	300
" "	11 58	Venus	63	48	37	25	350	+ 4	Streak	2
1897 " 22	6 23	∨ Venus	59	35	171	S	218	+ 10	Uncertain	2
1900 " 27	11 42	3 × Venus	76	67	34	42	136	+ 34	Streak 13 min.	5
1899 Nov. 14	17 40	∨ Venus	71	42	46	R	193	+ 27	Streak 5 min.	2
" " 15	16 49	Venus	83	50	43	R	150	+ 20	Leonid	5
" "	16 50	"	82	45	49	R	151	+ 20	"	3
1900 " 27	11 10	∨∨ Venus	57	17	40	S	47	+ 45	Broke into fragments	3
1897 Dec. 9	9 47	∨∨ Venus	76	21	90		113	+ 32	Geminid	5
" 12	8 6	∨ Venus	112	19	151	30	80	+ 23	ζ Taurid	5

continent of Europe the much greater expanse of territory makes the circumstances less favorable for though, proportionately with the larger area, more fireballs appear than in England, the

same objects are not often witnessed by many astronomical observers capable of suitably describing them as the great distances separating the principal stations where the observers reside must cause a different set of meteors to be seen at each place unless in very special instances.

In the column headed "magnitude" the letter "F" signifies "Fireball." In such cases the brightness was variously given by the observers and this must necessarily often occur inasmuch as they occupy stations differing greatly in relative distance from the object described. A person in a locality directly under a fireball near its brilliant termination at a height of 25 or 30 miles, will sometimes estimate it as affording more light than the full Moon while another very distant observer who views the meteor dimmed in mist near the horizon will allude to the object as not brighter than Jupiter.

The letters "R," "S" and "M" in the column headed "Velocity" indicate "Rapid," "Slow" and "Medium" respectively. In these instances the exact rate of velocity in miles per second could not be well determined from the observations owing to discordances in the estimated durations of flight.

ON THE MOTION OF THE NEBULÆ IN THE VICINITY OF NOVA PERSEI.*

J. C. KAPTEYN.

The discovery by Perrine that the nebulæ around Nova Persei show an annual proper motion of about 11′ is certainly one of the most startling that has been made in this era of remarkable events.

The position of the Nova, which, like nearly all novæ is very near the Milky Way, at least goes to show that these objects probably do not belong to a system very near our own, and the presumption thereupon comes that the parallax will not exceed one, or at the most, a few hundredths of a second.

With a parallax of 0″.01, as one would judge from the observed proper motion, we would have a linear velocity that is comparable with that of light if the motion is perpendicular to the line of sight. If, however, the motion is not perpendicular to the line of sight the velocity is still greater.

It may be that for this particular Nova, leaving out of account

* Translated from the German in *A. N.* 3756, by Edward A. Fath, Carleton College, '02.

its proximity to the Milky Way, the parallax may be exceptionally great. A proper motion of 1″, which seems probable from an article by Bergstrand (*A. N.* 3748) is in favor of such an assumption. But even if we assume a parallax of 0″.10, the linear velocity must exceed the mean velocity of the stars a thousandfold. One will be inclined to accept the existence of such a velocity only when there is not, at hand, a more plausible explanation.

The assumption might be made that accidentally we see the nebulæ in the same direction as the Nova, but that in reality they are much nearer. Even with such an assumption one is led to no less nearly insurmountable difficulties. Under these conditions it seems to me that the following explanation is, as yet, the best way out of the difficulty.

The nebula that surrounds the star has no, or only a very faint, luminosity of its own and the action on the photographic plate is produced simply by the reflected light of the Nova itself.

It is clear that the light which at any instant radiates from the Nova reaches us more quickly upon the direct way than upon the indirect which is occasioned by reflection from the nebulous masses. The delay will be t days for those parts of the nebula that are in the ellipsoid of revolution whose foci are in the Nova and the Sun, and whose semi-major axis equals

$$\text{distance of Nova} - \text{Sun} + \tfrac{1}{2}\, vt,$$

(where v is the distance traversed by light in a day).

That part of the ellipsoid of revolution which is near the Nova can unquestionably be exchanged for a paraboloid of revolution whose focus is in the Nova, whose axis passes through the Sun, and whose parameter is equal to vt.

If the light of the Nova was bright enough only T days after its first outburst for the reflected light to have any action, then the reflected light which is noticeable t days after the observed outburst came from a shell which is enclosed between the confocal paraboloids whose parameters are $v\,(t - \mathrm{T})$ and vt.

As time passes this shell increases in size so that new parts of the nebulous masses are illuminated while others lose their light. It is clear that uninterrupted observation would gradually show us the entire structure of the nebula in the same way that the biologist learns the structure of an organism by a series of consecutive cross-sections; only here the sections are not between plane surfaces but between paraboloids of revolution.

The information we have up to this time (I am acquainted

only with the contributions of Wolf, *A. N.* 3736; Ritchey, *Astrophysical Journal*, October; *A. N.* 3750; Perrine, Lick Observatory *Bulletin* No. 10), seems to me to be in accordance with the assumption that the nebulous mass in the vicinity of the Nova consists largely in streamers enclosed in a space which is plane on the sunward side. This plane must have an inclination of about 79° with the line of sight and such that the southwest portion is nearest the Sun while the Nova must be near this plane, not having penetrated far into the nebulous mass.

The cross-section of a paraboloid of revolution by a plane inclined to the axis is an ellipse, which is projected as an eccentric circle on a plane perpendicular to the axis.

In our assumption the outer boundary of the visible nebula should be a circle whose center lies northeast of the Nova, having an eccentricity of about 0.19 (= cos 79°). This coincides very well with the drawing by Ritchey in the *Astrophysical Journal* for October, p. 167.

In accordance with our assumption as to the bounding plane and the position of Nova with reference to it, the circumference of this circle must increase proportionately with the time as long as the boundary of the nebulous masses in this plane is not reached.

This is in accordance, even quantitatively, with the observations of Perrine (Lick Observatory *Bulletin*, No. 10) and Ritchey (*A. N.* 3750, second telegram, according to which the nebula is probably expanding in all directions). Then too, the sharply defined circumference which Ritchey's photograph shows on the south side is in good accordance with what one would expect.

The illuminated portion of a nebulous streamer which appears as a small condensation in the nebula will, of course, as time passes, move along the streamer. The direction of the motion observed by Perrine discloses to us the direction of these nebulous streamers. The observed motion of the various nebulous condensations need not, therefore, be parallel or radial, but may even be apparently directed toward the Nova. The parallax of the Nova is found to be about 0″.011.

It appears to me to be entirely too early to go farther into the details. I have simply called attention to this theory so that by having it in mind observations could be made to prove or disprove the hypothesis.

The main question which naturally arises is whether, under the existing conditions, the reflected light is sufficiently strong to have any appreciable action on the photographic plate.

As far as I know we have not sufficient data to answer this question with certainty, but by carefully following the phenomenon in question we may be able to find the solution.

THE ECLIPSE OF THALES.

W. H. S. MONCK.

FOR POPULAR ASTRONOMY.

The article of the Rev. Q. A. Wheat will, in the minds of many persons, render confusion worse confounded. For my own part, it merely confirms the view which I previously held as to the impossibility of identifying early eclipses owing to the indefiniteness of the historic record, and the consequent impossibility of checking the correctness (or incorrectness) of our present eclipse tables by means of these records.

The eclipse of Thales was long set down as having occurred in the year B. C. 610, but the late Professor Airy using the improved linear tables of Hansen altered the date to B. C. 585 which latter date is adopted without hesitation or doubt in many modern text-books. Professor McFarland, however, has called attention to many other dates assigned by various authorities and I have seen (for I did not read the article) that Mr. Stockwell has lately returned to B. C. 610 with a possible alternative of B. C. 603. Now Mr. Wheat gives us B. C. 547. Thales was probably dead in the latter year but Herodotus does not state that he lived to see his prediction verified. His disciples would have recollected and recalled it; but I think to satisfy it, the eclipse must have been total at Miletus.

However on looking over an account of ancient eclipses I found another which bears so strong a resemblance to that of Thales that I can hardly regard the two as distinct. It is recorded by Xenophon and was central at Larissa. It put an end to a war like that of Herodotus, though not quite in the same manner; and in both instances the Medes were one of the belligerents though in Xenophon's narrative the Persians take the place of the Lydeans in that of Herodotus as their opponents. Is it likely that within some half century at the outside two distinct wars in both of which the Medes were engaged should have been stopped by a total eclipse of the Sun? If not, we must conclude that Herodotus and Xenophon are describing the same eclipse. In Chamber's *Descriptive Astronomy* the date of Xenophon's eclipse is given as B. C. 557 though with some doubt. A slight

alteration would make this fit in with Mr. Wheat's total eclipse of B. C. 547—Xenophon being regarded as a more reliable historian than Herodotus. But can it be said that either Herodotus or Xenophon fix the date of the eclipse within twenty years? If not, what ground have we for assuming the perfect accuracy of our present lunar tables when carried back 2,500 years? A very slight error would shift the track of the eclipse by some hundreds of miles.

Another point is, I think, worth noticing. If we put together the different eclipses (computed from the tables) which are supposed by some one or other to have been that of Thales, we are driven to conclude either that total eclipses of the Sun were much more numerous in Asia Minor about the time of Thales than they are now, or else that a number of those set down were not (in that locality) total eclipses at all. Further, if the eclipse of Thales had such startling effects on the combatants, the natural inference is that the phenomenon had hitherto been unknown to them and came upon them completely by surprise. If this be so the numerous eclipses mentioned by different writers could hardly have affected the region in question. The error may have been in the calculation, not in the tables; but there is a strong suggestion of error somewhere. And I should not be surprised to find that according to some computers there was no total eclipse in Asia Minor at the date confidently fixed on by others for the eclipse of Thales. Most of Mr. Wheat's eclipses seem to me to be "vacant chaff well meant for grain."

There are no two subjects which seem to me so little likely to throw any real light on astronomy as Ancient Eclipses and Non-Euclidean Geometry. What is the use of arguing "If our tables are right a total eclipse took place at this date; and we have a record of an eclipse which seems to be limited to some twenty or thirty years before or after it; therefore the observed and computed eclipse must have been the same?" As to Non-Euclidean Geometry, I believe it will be found that Euclidean Geometry is covertly assumed in the fundamental principles employed. How for instance can we obtain an algebraic expression for a right line or a circle on really non-Euclidean principles?

Leonids at Los Angeles.—The display of the Leonid meteors at this place Nov. 15, 1900 was quite marked. Just before light on the morning of the 15th one watcher counted 385 in less than one hour. Some of the meteors left brilliant trails of green and red. At one time 100 meteors were counted in 16 minutes.

DOUBLE-STAR OBSERVATIONS AT THE FLOWER OBSERVATORY.

S. W. BURNHAM.

For Popular Astronomy.

A most valuable and interesting contribution to the literature of double stars has lately been issued from the Flower Observatory of the University of Pennsylvania. This handsome quarto volume of 146 double-column pages contains the micrometrical work and discoveries of Mr. Eric Doolittle, the son of the Director, Professor C. L. Doolittle. The work was done with the eighteen-inch equatorial in 1897 and the three following years. The object-glass by Brashear was found to be practically perfect in definition and light power, and satisfactorily showed the severe tests which are found in some of the β stars discovered with the 18½-inch of the Dearborn Observatory. The mounting by Warner & Swasey proved in all respects equally satisfactory, the clock giving a uniform and steady motion, and the instrument as a whole convenient to handle. The micrometer is similar generally to those in use at the Lick and Yerkes observatories, and is provided with the same illumination of the wires. Mr. Doolittle finds that the oil lamp gives a better wire under illumination than the electric lamp. This has been the experience of others, and is doubtless due to the fact that the bulb is placed much nearer the wires than the swinging oil-lamp. The distance of the latter is usually at least three times as far from the fixed wire, and unless the outer lens of the eye-piece is covered by a cap with a small aperture, the sharpness and clearness of the wires under the nearer illumination is more or less seriously affected. The adopted value of one revolution of the micrometer screw from a large number of transits is 13″.171.

The measures cover more than 900 different pairs. Each star as a rule was measured on at least three different nights, and many of them on a greater number of nights, so that the mean results are as accurate and reliable as they could be. The measures are remarkably consistent, and bear evidence of the care with which the whole work has been done.

The working list represented here contains 348 of the β stars, and 471 miscellaneous stars, principally the neglected pairs of the Herschels and Struves. The measures of the β stars were

kindly sent me from time to time, and the mean results of the work down to the latter part of 1899 are incorporated in my *General Catalogue*, issued early in 1900 as Vol. I of the Publications of Yerkes Observatory. Mr. Doolittle has also re-measured 55 of the stars observed by me at Mt. Hamilton from the A. G. Zone Catalogues. One of these, Krueger 60, has turned out to be a pair of considerable interest from the proper motion of the components. For such small stars, the movement is large. The members have a different rate of motion but in nearly the same direction, like the components of 61 Cygni.

The measures generally have a special value because there was good reason in nearly every instance for putting the pair on the working list, and there was little or no probability of duplicating the work of any other observer. After these careful and repeated observations, most of the pairs, other than those in rapid orbital motion, will need no further attention for perhaps a quarter of a century or more.

The attempt was made to find new pairs, but in course of the work twenty-two pairs with distances 1″ to 2″ were noted and fully measured. The most of them are comparatively small stars, but they are of a class likely to furnish some interesting systems hereafter.

This volume is beautifully printed and conveniently arranged for reference and use, and is remarkably free from errors and mistakes of all kinds, showing great care in preparation of copy and proof-reading, as well as in making the measures themselves. The only error I have found which is worth calling attention to, is one of my own, and occurs on page 21 in connection with the measures of H 637. I observed this pair on one night in 1877, and the distance as printed in my observations of that time was 25″.92. Mr. Doolittle on three nights made the distance 31″.36. Of course, such a change is highly improbable, and I therefore looked up my original record of the measure, and found that a blunder had been made in the reduction, and that the measured distance was really 31″.50, thus agreeing with the later position and showing no change at all.

It is to be hoped that this work, for which the observer has manifested such special fitness and zeal, will be continued regularly at the Flower Observatory. The field is a wide one, and the laborers none too many.

YERKES OBSERVATORY, Jan. 27, 1902.

A LABORATORY FOR GENERAL ASTRONOMY.

MARY E. BYRD.

FOR POPULAR ASTRONOMY.

The term, laboratory, in connection with astronomy at once suggests the question,—What is an astronomical laboratory, and how does it differ from an astronomical observatory? To find an answer we may briefly consider what facilities are needed by beginners who are taking up the study of general astronomy for one or two terms.

A decade or two ago it would have been necessary to begin further back and defend the use of laboratory methods. Today, however, it is generally conceded that our students should watch the heavens by day and by night, and deal directly with objects and motions in the celestial sphere. First and foremost, then, they must be provided with a place for seeing the dome of the sky; for their observing is not to be confined to a few bodies, nor to the limited fields of the telescope. The whole heavens is their province. It is for them to trace out the changing diurnal paths of Sun, Moon and planets; to track their winding ways among the constellations; to decipher, from diverse apparent motions, the uniform order of march imposed upon the host of stars; to find out how, in different seasons, the circle of the ecliptic and the arch of the Milky Way span our heavens with regard to zenith and horizon; to require of Sun and stars that they "stand and deliver" data for determining latitude and time; to gauge by comparison stars the waxing and waning of Venus and Mars, Algol and Mira; and to examine with low magnifying power, spots on the Sun, lunar markings, the bright planets, and star clusters.

To cope at first hand with these and similar problems will require approximate meridian lines, gnomon posts, sun-dials, plumb lines, instruments for measuring angles of azimuth and altitude, and a pair of field-glasses, or a small telescope. It seems not unfitting, therefore, to apply the term laboratory to the combined facilities offered by an observing station, with its appropriate instruments, and a room for desk work where observatorial data are reduced and interpreted. Indeed, it is easy and natural to go a step further and call the pure observing field or sky work and all processes of handling data, laboratory work. In this sense, though rather loosely, the term is employed at Smith College where an astronomical laboratory is in use. As

the work of establishing it has been done under my direction, perhaps I cannot better give meaning and content to the general idea of such a laboratory than by describing this one.

The building itself is an addition to the College Observatory, and its flat roof, commanding a good horizon line to the south and west, is used mainly for naked-eye observing, pure and simple. At present the only appliances provided are a high desk-like shelf for dark lanterns and record books, and a number of plumb-lines, some of which are permanently fixed above the railing on the south, while others are attached to movable tripods. From the roof a winding stairway of iron leads to the rooms below, but they are usually reached from the ground entrance on the east. To the right of this entrance is a small room used in the day time as an office, but in the evening often thrown open to half a dozen students, who are mapping the same constellation or engaged on the same working-list, so that they can receive, promptly, common directions and individual criticisms. On the left is the instrument room. Here, we find most of the table and and floor space taken up by "transit-tubes," "Circles," and sun-dials. On the south wall hang a row of cross-staves, and on the north are long shelves for field glasses, dew caps, dark lanterns, and many little things that must be close at hand. Near the window stand Wilson's "Universal Equatorial," two home-made telescopes, aperture 1.5 inches, and a poor decrepit theodolite, whose little telescope is, however, often more serviceable than field-glasses. The narrow space below the window is utilized by a rack for straight-edges, jointed-rules and protractors.

Not all instruments are kept in the instrument room. In a way, the whole equipment of the Observatory is levied upon for elementary instruction. This is especially true of the sidereal clock. Below its dial is placed a small glass-covered frame, and the card exposed there each week gives for every day the sidereal time of standard noon. Having, then, the error of the clock, students are required to find the error of their watches within a second and so obtain a check on their observations for time. In preparing for evening observing, where sidereal time needs to be known only within a minute or two, it can be read directly from Skelton's sidereal indicator which hangs in the laboratory room. the north and south.

It is this room which is pre-eminently the centre for all the work done by beginners. Here are their desks with drawers for laboratory manuals record books, uranographies, almanacs, rulers, dark-glasses, opera-glasses and other pieces of small ap-

paratus. Here they first report when they come, either for day or night work, and from here they go up to the flat roof over head, or out to the observing stations near meridian stones on

At the desks most of the evening records are made, including drawings as well as descriptive notes, for, by using star lines and angles, much of the sky data is held in mind till it can be recorded here. The study of the *American Ephemeris*, of star maps, orreries and globes; numerical reductions, plotting on rectangular paper, and checking by the celestial globe are carried on here. The room, itself, is large and pleasant, with steel ceiling, plain brick walls and hard wood finishing. It accommodates about forty students at desks; nine windows light it in the day time and at night four clusters of electric jets.

Instead of the usual period of two or three hours for a given class, this laboratory is open and assistance given during twelve or fifteen hours in the day time, and for two hours on each of four evenings a week if the sky is clear. Thus, inconveniences caused by dependence upon the weather are compensated in part, since individual students can choose their laboratory hours with nearly the same freedom as study hours. The following is a brief list of points made out before hand by an instructor for day laboratory work on the afternoon of December 6th:

1. See that students check their last observed noon altitude of the Sun from declinations in the Old Farmer's Almanac.
2. Have as many as possible read off the right ascension and declination of Vega from Young's "Uranography," express right ascension in degrees and check result on Heis's Atlas.
3. Refer Misses G., R. and W. to *Ephemeris* data for determining Moon's phases in standard time here for December.
4. Help Miss J. to get a check on the globe for the altitude and azimuth of Venus observed last night with Circles.
5. Give directions to those who are ready to plot their diurnal paths of the Sun. Let them put in the half day path of the Moon and several positions of planets.

If we look over this laboratory the first week in December, we see that the large black-boards in the rear are marked off into a number of sections with the days of the week at the left, and at the top headings indicating different observations, such as: "Time of Apparent Noon with the Transit Tube;" "Latitude from Altitude of North Star with Circles;" "Transit of β Ceti, off Meridian, for Length of Sidereal Day, with Plumb Lines."

Beneath these headings are ruled spaces and the names written in show just what students have taken appointments on given dates for observations which require instruments and special

help from instructors. In the front of the room the black-board back of the teacher's platform is given up to construction lines for star maps. Directions for Auriga read:

Take $\alpha\iota$ as reference line.
Having estimated $\alpha\eta$ in $\alpha\iota$ put in η and ζ.
Having estimated $\alpha\epsilon$ in $\alpha\eta$ put in ϵ.
Estimate $< \epsilon\alpha\theta$.
Compare $\iota\theta$ with $\iota\alpha$ and put in θ.
Having estimated the $< \epsilon\beta\theta$ place β by comparing $\alpha\beta$ with $\beta\theta$.

The reference line mentioned is fixed in length and direction by a card-board pattern so that the constellation shall be of good size and well placed on the page. There are a number of these patterns, for different constellations, on a table near the platform. Star atlases, star maps and lunar maps are kept in a rack in front of the teacher's desk, and on the right and left are sidereal globes, twenty inches in diameter. A small orrery stands near one of them and back of the other on a wide window-sill is a row of dummy clocks which are serviceable in showing for a given instant the clock readings for Greenwich, standard, mean local and apparent times. The portable black-board at the left of the platform is used for miscellaneous purposes, and in the week considered is occupied by a *rush working-list*, that is a list of pressing observations which, in as far as they have not been completed, should receive the prompt attention of every student on her first observing night. A general program like this, however, does not in any way bar out the individual lists required and those coming into the laboratory in the evening are often met with the request, "Let me see your working-list for tonight."

The individual lists given below were made out by students who began General Astronomy at the opening of the current college year. As the weather was favorable on both evenings almost everything planned was accomplished.

Working-List for Friday, October 25, 1901.

1. Find how long it takes the Sun to set.
2. Identify the constellation seen first in the west just after sunset, to show whether the Sun is moving among the stars.
3. Observe setting point of Venus, to compare with setting point of the Sun.
4. Measure with jointed rulers and protractor the Moon's azimuth at rising, first of several observations to find time and place of rising of Hunter's Moon on successive nights.
5. Determine the constellation in which the Moon is found by aligning from bright stars.
6. Identify twenty seas and craters on the Moon with one of the home-made telescopes.
7. Answer five or six miscellaneous questions on the Moon. M. A. V. K.

WORKING-LIST FOR THURSDAY, NOVEMBER 1, 1901.

1. Fix with Circles the place of Jupiter and Venus at setting.
2. Map twice, with an hour between, the constellation Auriga with reference to the horizon, part of data for answering question, "How do the stars move?"
3. Measure altitude of North Star, off the meridian, for latitude.
4. Look at ξ Ursæ Majoris with naked eye and field-glasses and note difference.
5. Count the stars seen in the Pleiades with naked eye and with field-glasses.
6. Map several constellations.
7. Place the Moon in a constellation by angles and distances from reference stars.
8. Answer general questions on the Moon. B. H. H.

Our laboratory is a busy, picturesque place in the evening with students passing back and forth with dark lanterns, a group of eager questioners here, quiet desk work going on there, and perhaps half a dozen maidens lined up in the main aisle waiting to have star maps criticised or approved. A listener may hear some rather peculiar questions and remarks, such as, "Where is that other transit-tube girl? She ought to be lighting her lanterns." "I do not think I can do that tonight. I have an appointment with the Moon." "Can I get Fomalhaut on the roof now?"

Whatever may be said for or against such a laboratory as that which has been described, it is certainly characterized by enthusiastic effort and vivid impressions, and it is doubtful whether any one who has taught astronomy with a laboratory would find it endurable to go back to the old ways.

SMITH COLLEGE OBSERVATORY,
NORTHAMPTON, Mass., Jan. 25, 1902.

CHAPEL ADDRESS JAN. 8, 1902.

J. K. REES.

Our chaplain has asked me to give you some of the ideas that are especially impressed on the astronomer as he studies deeply the profound mysteries of the heavens.

What do our eyes see? What does the telescope reveal?

We can count with the naked eye a few thousand (between 6,000 and 7,000) stars, and watch the movements of several planets, as did the astronomers of old. From such observations made with sighting rods without telescopic lenses, were obtained the material by which Copernicus and Kepler were led to the grand discovery of the true solar system. Then the Earth ceased to be the centre about which all the heavenly bodies circulated.

Our place of abode was simply one of a number of bodies moving around a central sun. When the telescope was invented and observations were made with this space-penetrating instrument the further insignificance of the Earth was established. She was found to be one of the *small* bodies of the solar system—one of a family of planets depending on the great Sun's attraction. Not near enough to any of her neighbors to enable the astronomer to decide whether or no human beings had possession.

Then a study of the starry vault of which Shelley wrote:

> . . . "Heaven's ebon vault
> Studded with stars unutterably bright
> Through which the Moon's unclouded grandeur rolls
> Seems like a canopy which love has spread
> To curtain in her sleeping world.

This study brought out an amazing, an awe-inspiring number of stars. From a few thousand stars the number has gone on increasing until it is estimated that with the Lick telescope, possessing an eye 36 inches in diameter, there could be counted more than one hundred millions of stars, and all at such distances as fairly to stagger our finite minds.

But the eye of man is sensitive only to a comparatively small number of rays of light, and that light must be of a certain degree of intensity; above and below the rays visible to the unaided eye are other rays, that can be rendered visible only by special means. Using photography, astronomers have shown that in long exposures lasting in some cases twenty-five hours, pictures can be taken of stars, nebulæ, and comets which we can never hope to see with the same detail in the largest telescopes. Measurements of double stars and the application of the spectroscope, tell us much concerning stellar motions; and a careful study shows that there are many gigantic stellar systems. Systems like our solar system, but built on a scale millions of times greater.

The devout astronomer as he thinks of these myriads of worlds placed in the depths of immeasurable space, bows his head in *awe*-ful reverence, and confesses the stupendous insignificance of this little earth and his own utter unimportance. He exclaims with outstretched hands: "Oh, Lord, what is man that Thou are mindful of him," but he feels he *is a part, though a very small* part of a grand unfathomable plan, one infinitesimal link in the great chain of events.

A feeling similar to this must have affected Lord Roseberry who lately said, in an address before some university students in England:

" . . . Against one sublime department of science, I would beg to enter a respectful warning. I do so with some apprehension, because I have distributed a prize in that department of science tonight. It is dangerous, in my judgment, to study astronomy, for astronomy kills ambition. What mind, after contemplating the eternal procession of unnumbered worlds, perhaps with their infinite generations of life, their various splendours, their history, their endless rolls of celebrity, their separate myriads of heroes, can return without a disheartening sense of the pitifulness and futility of everything on his own narrow universe."

In this subdued and humble frame of mind the astronomer rises from his knees, and with deep-felt humility, looks about to discover *what* he can learn. He realizes that the "Universe is a book written for man's reading," and only patient study can solve the problems written on the mysterious leaves. As he ponders over the mighty problems presented to his mind and surveys the grandeur of the heavens, he is ready to exclaim with the Psalmist "The heavens declare the glory of God and the firmament showeth His handiwork." The might, majesty and dominion of the Creator stand out before him in grand and impressive relief.

He begins to study deeply the mysteries of the heavens and he finds unbounded delight in gaining a comprehension of the laws that bind the universe together. Those laws are so applied and worked out that the astronomer is able to follow the Moon in her journey round the Earth, to predict her place at any time, and to foretell to a second the coming of an eclipse. He pushes his study deeper and he discovers new planets, new worlds, by the use of mathematical analysis which takes into account the laws of gravitation. "Forever invisible to the unaided eye of man, a sister-globe to the Earth was shown to circulate in perpetual frozen exile, at thirty times its distance from the Sun." The discovery of Neptune was certainly an intellectual triumph!

The movements of the planets are now so well understood that it is possible to put down in tables the positions these bodies will occupy many years ahead.

The spectroscope enables the scientific expert to read the light-sent messages coming not only from the giant Sun and our sister planets but also from the stars—so distant that the message speeding onward at the rate of 186,000 miles per second takes more than four years to reach us from the nearest star. But even the tremendous distances do not prevent the astronomer

from learning something about the character and the movements of these distant universes. The *intellectual* conquests are so *mighty* that the man *feels* that *in him* there resides a *something, a soul,* that causes him to delight in the search for truth.

Mazzini appreciated this view, for to one who asked him, "What would you have taught in schools," he replied, "One thing at any rate in all, and that is some knowledge of astronomy. A man learns nothing if he hasn't learnt to wonder, and astronomy better than any science teaches him something of the mystery and grandeur of the universe. Now a man who feels this will soon feel something of his own greatness and mystery and then for the first time he is a man."

He feels the touch of a divine nature which teaches him to believe that the Bible has shown him a great truth—he is truly a son of God and in his studies and devotion to truth-seeking he is evolving the divine nature in himself. Astronomy proves to him the "divine pedigree of man," and he yearns to be like his Father in Heaven.—"To be perfect as God is perfect is to be an intellectual and moral prime mover, equipped with one's own machinery, vitalized, energized and made active by the fires of eternal truth."

On me astronomy in its sublimity, grandeur and depth impresses these three thoughts: the amazing insignificance of mortal man viewed from the material side; the wondrous beauty and splendid complexity of the universe; and lastly the uplifting conviction that man has the highest authority for believing that in breathing into him the breath of life the Creator has endowed him with divine qualities.

COLUMBIA UNIVERSITY,
New York.

ECLIPSE AID TO CHRONOLOGY. II.

REV. Q. A. WHEAT.

FOR POPULAR ASTRONOMY.

Probably objection may be offered to my interpretation that the "darkness over all the land of Egypt" some days before the exodus may be explained by the solar eclipse B. C. 1475, March 30, because "there was light in the habitations of the children of Israel."

Without discussion I simply refer the objector to a similar expression under relatively similar conditions of the Jews and their

enemies, recorded in Esther 8 : 16—"The Jews had light, and gladness, and joy, and honor"—and I leave the matter to his own thought and conclusions.

Another eclipse is accepted as explaining a prediction by Ezekiel (chapter 30, verse 18) determining the day in which was fought a decisive battle involving a restriction of the power of Egypt, namely, eclipse of the Sun, B. C. 542, July 31, in the morning.

In the record II. Kings 23 : 31, 35, and in Jeremiah 37 : 5, 11, it is evident that when Nebuchadnezzar appeared before Jerusalem, and began the seige of the city in B. C. 543, he was interrupted by news of the advance of Pharaoh-Neco to the relief of the city and that he temporarily raised the seige to meet the advance. Neco was defeated, and probably killed in the battle on July 31, B. C. 542, which was the sixteenth and last year of his reign, and his army returned to Egypt having lost king and all the country between the Euphrates and Egypt (See Jer. 37 : 7; II. Kings 24 : 7) and Nebuchadnezzar returned to the siege of Jerusalem, as was predicted by Jeremiah, and took the city in B. C. 541 and destroyed the temple about one month later.

Now one more application illustrative of the value of "Eclipse Aid to Chronology."

If we accept the eclipse of the Sun B. C. 1475, March 30, about 4:30 p. m. local time northern Egypt to explain the "darkness over all the land of Egypt," when Moses and Aaron left Amenthesuphis' palace that day, evidently according to the sacred text, Abib 14, of the Egyptian calendar, the day within which the Exodus of Israel from Egypt happened, was only a few days later than that of the eclipse. But when, and by what calendar measurements prior to the reform by Julius Cæsar in B. C. 46 (50?) what day was the recording anniversary of the Exodus event?

Assuming that the reader is familiar with the calendar difficulty *in gain of time prior to the Julian reform*, I suggest that only one event of history will definitely determine the true date of the Exodus, and that event is the Crucifixion of Jesus Christ, which occurred at the time of a Passover festival.

The Passover and the Feast of Tabernacles were "fixed" festivals, the days of each definitely determined in regular calendar succession and six months removed from each other. The other festival (Weeks) was "movable" and depended on the time of harvest, *originally*.

The time of the Crucifixion of Jesus, and the time of his birth, about the time of a Feast of Tabernacles, although positively

unknown, are open to fair argument on the circumstantial evidence that we find on record; and I propose to show that his ministry began in the latter part of spring, a few weeks after his baptism, and that his crucifixion, three years and a half year later was in the fall and on A. D. 29, November 24.

Two facts are tortures to an investigator who proposes a radically new theory, *i. e.*, possible stultification by a wiser; and the probable ridicule of a more ignorant man than himself; however, in support of my theory I offer the following:

1. Tradition is at fault in supposing that because Abib 14th, the date of the Exodus, being in the middle of the month, therefore was at the time of full Moon; for the reason that Abib evidently was the seventh month of the Egyptian calendar, and that calendar was not lunar. Its year of 360 days was divided into 12 months of 30 days each, and 5 days added making 365 days (Herodotus B. 2, ch. 4), our common year; and therefore, as that calendar was not regulated by the lunations, Abib 14th may have occurred on a new Moon, or other day of the month.

2. Smith's Bible Dictionary, word "Month," says,—"From the time of the institution of the Mosaic law downwards the month was a lunar one." Therefore did not synchonize with the Egyptian, or common year; nor with the true year, which was unknown, at least practically, until the Julian reform.

3. However, it is well known that Josephus synchronized the Hebrew and Macedonian calendars; and that the latter had an intercalary month every three years to adjust it to the common year (See Carey's Herodotus B. 2, ch. 4); evidently every 37th lunation (month) of those synchronized calendars was the "Veadar" of the Hebrews.

4. All calendars, prior to the Julian reform, were regulated by apparent time; which was found to have been short of the true year 0.241+ of a day; making a gain of calendar over true time 369 days in an interval of 1503 years, 7 months, 24 days, Julian time; determined by eclipse interval between B. C. 1475 (— 1474) March 30, and A. D. 29, November 24.

5. That the priest-hood of Hyrcanus I began with the Passover, *i. e.* the beginning of the Hebrew year, on a Sabbatic year, and shortly afterward was "a rain at the setting of the Pleiades" (Ant. B. 13, ch. 8, sec 1, 2); Whiston's note—"about February;" and this connected with the text a little farther on—"But when the feast of Tabernacles was at hand"—according to my computation, in April.

And, also, that the summer was between the Feast of Taber-

nacles and the Passover in the reign of Herod is evident; for the drowning of Aristobulus "was in the midst of a hot day," *shortly after* the feast of Tabernacles (Ant. B. 15, ch 3, sec 3).

6. Whiston's note on the death ot Philip, the tetrarch (Antiquities B. 18, ch. 5, sec. 6): "For since Herod died about September * * * and Tiberius began, as is well known, August 19th"—and compare this with Josephus' text on the funeral of Herod, and the impatience of Archelaus to be off for Rome after Herod's funeral; but that he was detained by the Passover (Ant. B. 17, ch. 8, sec. 4 and B. 17, ch. 9, sec, 1, 2, 3). "This was granted by Archelaus, although he was mightily offended at their importunity, because he proposed to himself to go to Rome immediately, to look after Cæsar's determination about him. * * Now upon the approach of that feast of unleavened bread, * * * which is called the Passover. * * * Then did Archelaus order proclamation to be made to them all, that they should retire to their own homes; so they went away, and left the festival. * * So Archelaus went down to the sea, and sailed for Rome."

(See, also, War B. 2, ch. 1), "For when he (Archelaus) had mourned for his father seven days, * * * he put on a white garment and went up to the holy temple, where the people accosted him with various acclamations. He also spake kindly to the multitude * * * as if he were already settled in the kingdom; but he told them withal." (See 3). "At these clamours Archelaus was provoked, but restrained himself from taking vengeance on the authors, on account of the haste he was in of going to Rome. * * * And, indeed, at the feast of unleavened bread, which was now at hand, and is by the Jews called the Passover, * * * these were followed by Archelaus' heralds, who commanded every one to retire to their own homes, whither they all went, and left the festival." So then, if Herod died in September, the circumstances show that the Passover was shortly after in the same season of the year.

7. The Gospel's tracing the ministry of John Baptist—beginning "in the wilderness of Judea:" in the low, tropical plain of the Jordan "where John first baptized," either in winter, or spring; then afterward in Aënon, where "many waters" accommodated the multitudes, (during the heat of summer?)

8. The Gospel's tracing the ministry of Jesus, beginning with his thirtieth year, which was reached at the end of his forty days' temptation period.

Two days after his baptism, Jesus went into the wilderness; thence to a very high mountain; thence to the city, Jerusalem

(perhaps on a feast of Tabernacles occasion), and to the top of the highest temple tower, when, (according to Luke) his temptation period ended.

Then he went to the Sea of Galilee, in the fishing season; called two men from their fishing; other two from their net mending, went into Capernaum, and lodged there that night. (See Mark for the ministry of Jesus).

The next day was a Sabbath and Jesus went to the synagogue, and receiving a book, he sought and found the passage of Scripture, Isaiah 61: 1, which he read in the hearing of the people, "closed the book and handed it to the minister, sat down," and the first words of his ministry were then uttered—"This day is this scripture fulfilled in your ears;" and the same day his work of miracles began, (shortly after "Tabernacles.)"

That same warm summer day, "at even when the Sun was setting (or 'did set'), they brought unto Him all who were diseased"—not the time of the year for exposure of the sick in the evening, if in cold weather, but in summer time quite necessary to avoid the heat of the day.

The next day Jesus began his tour of all Galilee; and appears to have visited his own city, Nazareth, the last before he returned to Capernaum, (Mark 1, 29 : 2, 1). After which "the Passover drew nigh"—after all his first summer's work, his first Passover during his ministry, in the fall of the year evidently.

Again, three years later, a Passover occasion approached. Five days before the day of the festival, palm leaves, and other leafy boughs of trees were borne, or strewn in the way of his triumph; hardly in the spring. The same evening he came to a fig tree in leaf, but no figs thereon "nothing but leaves: *for the time of figs was not*" (*"yet"* is a gratuity of interpretation). Even with the "yet," too early, or too late for fruit usually. Not too early for the habit of the fig tree is fruit first, then leaf. So then, too late, fruit borne and gone; "Some trees carry their fruit into the winter;" if so, frost has taken away the leaf. "Haply" Jesus may have found this tree beyond season; but it "was not the time of figs." Not a barren tree, men had eaten of it; but "no more, forever;" blighted but now answers to a purpose.

The day of the preparation (for the Passover), on the night of which the Passover began, was the day of the crucifixion of Jesus. An incident of that event was "darkness over all the Earth from the sixth to the ninth hour." One o'clock and thirty minutes, afternoon, was its mean duration. A total eclipse of

the Sun, local time Jerusalem, 1:30 P. M., especially on a heavy day would occasion the darkness and its duration; and Abib 14th of the Hebrew calendar determined, and the day of "Exodus" calculated.

Such an eclipse is found in Professor Stockwell's list marked, "Phlegon, Olympiad 202, year 2; B. C. A. D. 29, November 24; local time Jerusalem, 1:43 P. M.; and, I follow in support with the demonstration:

Eclipse B. C. 1475, March 30 to A. D. 29, Nov. 24.
Interval Julian time 1503 years, 234 days.
Interval common time 1504 years, 238 days.
Interval gain by common time 1 yr. 0 m. 4 days.

Which shows the interval to have been 4 days longer than complete years. Since Abib 14, the day of the crucifixion, is definitely known, and on the hypothesis that A. D. 29, Nov. 24, was that day, Abib 14, would have been short 4 days from the other extreme of the interval and would have coincided with B. C. 1475, April 3, the day of Exodus; the fourth day after the darkness (eclipse) preceding the Exodus. Read the text in Exodus and conclude.

According to this showing and by common time, 365 days to the year (the time controlling the calendars before the adoption of the Julian reform) we have:

"Exodus," B. C. 1475, April 3.

"Birth" of Jesus on or about the feast of Tabernacles, B. C. 4, May —.

"Baptism" of Jesus, on or about A. D. 26, April 3.

Before I close, I call attention to another important feature of the "Eclipse of Phlegon." It is recorded to have occurred in "Olympiad 202 year 2;" therefore, the Olympiad era must have begun 809 years previously, *i. e.* in B. C. 780.

PORT REPUBLIC, Va.,
JAN. 4, 1902.

A New Catalogue of Variable Stars.—A committee of the *Astronomische Gesellschaft*, consisting of Messrs. Dunér, Hartwig, Müller and Oudemans, have undertaken the preparation of a Catalogue of Variable Stars. They request observers who have a considerable unprinted series of observations, which would be useful in the correction of elements, to publish them at once or to communicate them to Professor G. Müller, Potsdam Observatory. The Committee will also undertake the definitive notation of newly-discovered variables as soon as their light-fluctuations are certainly ascertained. They will shortly publish a list of variables discovered in recent years which are unnamed.—*The Observatory*, January 1902.

THE LIGHT CURVE OF THE NEW STAR IN PERSEUS.

CONTINUED FROM PAGE 96.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised.	Color
Apr.	h					
23	14.2	Stebbins	ν 2 N	4.20	4.17	
	15.2	Wilson	$\nu = \kappa$ 1 $\theta = \iota$ 2 σ 2 ψ = N 5 *l* 3 (72) = (71) 10 (83)		4.53	
	16.0	Hadden	Too low; but vis. to naked eye	4±		
	16.0	Townley	ν 3 *l*; κ 2 *l*	4.3	4.22	
	16.5	Aitken		4.5		
24	3.4	Stratanoff		4.88	4.74	
	7.1	Riccò	Photometer : ϵ, 725 PPD	5.72	5.49	
	7.5	Höhl		5.6		
		Oertel		5.4		
	7.8	Giovannozzi		5.4		
		Köhl		5.3		
	7.8	{Muller / Kempf}	Photometer : (85), (76)	5.46	5.64	RY
	8.0	Meyermann	*l*, (72) (71)	5.32	5.25	
	8	Schwab	N 1 (71); *l* 3 N 2 (72)		5.23	
	8.2	Ambronn	*l* 1 N 2 (72); *l* 1 N 2 (71); ν 3 N 1 (72)	5.22	5.10	R
	8.3	Collette	$< l$	5.9		
	8.5	Lockyer		< 5.5		
	8.5	Messow		5.3		
	8.5	Fauth	(72) 1 N; (71) 3 N 2 (83)		5.70	OR
		Plassmann		6.0		
	8.7	Luizet		5.3		
	9.0	Meyermann		5.32	5.25	
	9	Bosc	$< \chi > l < \nu$ and ψ	5.2		
	9.0	Ambronn	*l* 1 N 1 (72); *l* 2 N 1 (71); *l* 1 N 1 (72); N = (72)	5.22	5.10	
	9.0	{Muller / Kempf}	Photometer : (76) (85)	5.40	5.58	
	9	Epstein	(71) > (72) : = N > (86) > (83)		5.4	
	9.0	Wickham	(72)	5.40	5.40	R*
	9.1	McClellan	*l*, (72), κ	4.90	4.98	R*
	9.2	Williams	(71) 7 N 7 (83)	5.95	5.84	
	9.4	Williams	(71) 6 N 4 (83)	6.05	5.94	R†
	9.6	Bohlin	*l* 5 N 1 (72)	5.56	5.31	
	10.7	Bohlin	*l* 4 N 2 (72)	5.47	5.26	
	11.8	Messow		5.9		
	13.8	Messow		6.1		
	14.2	Comstock	N (72); (71) 2 N	5.45	5.46	
	14.5	Stebbins	N 1 (75); (71) 1 N; (72) 2 N	5.50	5.51	
	16.0	Hadden	Too low for accurate obs.	5.4		
25		Balassny		< 6.0		
		Köhl		5.6		
		Messow		5.8		
	7.7	Giovannozzi		5.5		
	7.8	Solá		6.5	5.7	
	8.1	Harkányi	Photometer	5.91	5.80	
	8.2 to 9.2	Ambronn	(72) 1 N 2 (83); (71) 1 N 3 (83); N = or < (71); (71) N 1 (83)	5.64	5.64	R
	8.2	Lockyer		5.8		
	8.2	Meyermann	(71), (83)	5.56		

* More red than on 23d. † Very deep intense red.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Magnitude. Revised	Color
Apr.	h					
25	8.6	Collette		6.1		
	8.7	Wickham	(83), (71), (72), DM 44°648	5.58	5.64	DR
	9.0	Butler		5.6		
	9.0	Bohlin	(72) 2 N 6 (83)	5.75	5.62	
	9.2	McClellan	(72), (79), DM 44°648	6 13	6.06	VR
	9.3	Williams	(71), 7 N 2.7 (83)	6.2	6.07	
		Sharp		6.0		
	9.3	Bosc		<5.5		
	9.4	Kustner	(72) 3 N		5.67	
	9.7	Epstein	N = (83); $<$ (86); (71) $>$ (72) $>$ (84) $>$ N		6.34	
	9.8	Bohlin	(72) 2 N 6 (83)	5.75	5.64	
	13.3	Bohlin	(72) 4 N 4 (83)	5.84	5.86	
	13.7	Hadden	: = *l*	5.2		
	14.0	Brenke	(71) 5 N 5 (83); (72) 2 N = (79)	5.8	5.77	
	14.0	Comstock	(72) 1 N; (71) 2 N	5.50	5.51	
	15.8	Stebbins	N 1 (75)	5.50	5.51	
	16.0	Townley	(71) 2 (83) (72) 2-3 N	5.6	5.58	
	16	Aitken		5.3		
26	7.4	Harkányi	Photometer :	6.08	5.98	
	7.5	Höhl		5.7		
	7.6	Muller	Photometer : (85)	6.08	6.36	
	8	Schwab	N = $<$ (72)		5.4	
	8.2	Kempf	Photometer : (85)	5.79	6.13	VR
	8.6	Collette	$<6^m$ star west of *l*	6.2		
	8.7	Bohlin	(72) 3 N 5 (83)	5.79	5.73	
	8.8	Solá		5.8	5.2	
	9.0	Fowler		5.5		
		Graff		5.9		R*
	9.0	Butler		5.5		
	9.0	Lockyer		5.6		
	9.1	Williams	(71) 8 N 3 (83)	6.2	6.07	VR
	9.3	Bohlin	(72) 4 N 4 (83)	5.84	5.86	
	9.9	Wickham	(71), (72)	5.40	5.38	R
	10.3	Muller, Kempf	Photometer : (85)	5.91	6.27	
	10.8	McClellan	(72), (79)	5.70	5.60	
	12.1	Bohlin	(72) 1 N 7 (83)	5.70	5.49	
	12.7	Wendell	Photometer	5.81		
	13.2	Furness	(72) 1 N 1 (83)	6.0	5.85	
	13.3	Hagen	(71) 10 (72) 6 N 20 (85)		5.91	
	13.4	Daniel		5.77		
	13.6	Zwack	(72) 6 N 15 (83)		5.65	
	14	Brenke	(71) 8 N 5 (83); (79) 1 N; (75) 4 N 5 (81); (72) 4 N 5 (83)	6.0	5.90	
	14	Young	(72) 1 N 1 (71)	5.2	5.36	
	14.0	Comstock	(72) 2 N; (71) 3 N	5.65	5.61	
	14.0	Stebbins	N (75); (71) 2 N; (72) 3 N	5.60	5.60	
	14.8	Wilson	ν 2 κ 2 ι = σ 2 ψ 5 *l* 5 (72) = N = (71) 10 (83)		5.37	
	16.0	Townley	(71) 3-4 (83); (72) 2 N	5.6	5.63	
	16.8	Aitken		5.4		
27		Messow		4.3		
		Graff		4.5		Y†
		Oertel	ν, κ, *l*	4.6		
	7.1	Riccò	Photometer : ϵ	5.20	4 97	

* Conspicuous red. † Bright yellow; like σ.

Date 1901	Gr. M. T.	Observer.	Comparisons.	Magnitude.		Color
				Obs'r.	Revised.	
Apr.	h					
27	7.1	Sviatsky		4.8		
	7.4	Muller	Photometer : κ	4.50	4.49	
	7.6	Kempf	Photometer : σ κ	4.62	4.62	W Y
	7.8	Muller	Photometer : σ	4.60	4.64	
	8.0	Butler		4.5		
	8.3	Bohlin	ν 4 N 1 σ	4.41	4.34	
	8.3	Harkányi	Photometer	456	4.41	
	8.5	Ambronn	ν 1 N 2 *l*; κ 2 N 3 *l*	4.40	4.36	
	8.8	Solá		4.7	4.3	
	9.2	Lockyer		4.4		
	9.4	Bohlin	ν 2 N 2 σ; κ 3 N	4.32	4.26	
	10.1	Bohlin	ν 3 N 6 *l*	4.39	4.27	
	13.0	Furness	ν 2 N 1 or 2 ψ	4.1	4.09	
	13.0	Jones		4.26		
	13.2	Zwack	ν 5 N 11 ξ		3.97	
	13.3	Hagen	ν 5 κ 5 N 7 ξ		4.00	
	13.5	Furness	ν 3 N = or 1 ψ	4.2	4.18	
	13.5	Wendell	Photometer	4.17		
	13.9	Daniel		4.55		
	14	Young	N 2 (71)	5.1		
	14.0	Furness	N = ψ		4.26	
	16.0	Townley	ν 3-2 *l*; κ 2 *l*; κ 2 N	4.2	4.21	
28	7.5	Höhl		5.4		
	7.7	Solá		6.2	5.4	
	7.8	Giovannozzi		4.9		
	8.1	Harkányi	Photometer	5.60	5.48	R
	8.7	Wickham	(72), *l*	5.20	5.30	
	8.9	Bohlin	*l* 3 N 3 (72)	5.37	5.20	
	9.0	Williams	(71) = N 10 (83)	5.45	5.35	
	9	Bosc	Much < ν	5.5		
	9.3	Collette		6.3		
	9.8	Bohlin	*l* 4 N 2 (72)	5.47	5.26	
	11.2	Bohlin	*l* 5 N 1 (72)	5.56	5.31	
	12.9	Wendell	Photometer	5.40		
	13.2	Jones		5.52		
	13.7	Daniel		5.35		
	13.8	Furness	*l* 2 or 3 N = or 1 (72)	5.3	5.26	
	14.2	Hadden	Trace > *l*	5.0	5.0	
	14.5	Brenke	(71) 4 N = (72) = (78); (75) 3 N 2 (80)	5.7	5.58	
29		Plassmann		5.9		
		Oertel	(71), (83)	6:		
	7 4	Harkányi	Photometer	6.17	6.07	
	7.8	Giovannozzi	Very uncertain	4.5		
	8	Schwab	(72) 3 N = (83)		6.34	
	8.5	Epstein	(71) > (72) > N			
	8.5	Luizet		5.5		
	9.1	Epstein	N : = (81) < (72); (71) = *l*		6.20	
	9.3	Bohlin	(72) 3 N 6 (83)	5.78	5.69	
	9.3	Meyermann	(72), (71) (83)	5.42		
	9.5	Ambronn	(72) 1 N 1 (83)		5.86	
	9.7	Robinson	(72), (79) *l*	5.56	5.55	VR
	10.6	Bohlin	(72) 3 N 7 (83)	5.76	5.66	
	13.2	Hagen	(72) 3 N 1 mag > (85)		5.7	
	13.2	Zwack	N 30 (85)		5.4	
	13.4	Daniel		5.95		
	13.5	Furness	*l* 2 N 3 (72)	5.2	5.17	R*

* Quite red.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised.	Color
Apr.	h					
30	7.2	Müller A	(71)	5.3		*
	7.3	Riccò	Photometer : ϵ	5.70:	5.5	
	8·8	Collette		6.3		
	9.0	Bohlin	(72) 4 N 7 (83)	5.79	5.73	
	9.2	Lockyer		< 5.6		
	9.7	Fowler		5.8		
May	10.0	Bohlin	(72) 3 N 7 (83)	5.76	5.66	
1	7.2	Müller A		5.0		*
	7.6	Riccò	Photometer : ϵ	6.40	6.17	
	8.0	Robinson	(72)	5.50	5.50	
	8.2	Wickham	*l*, κ, (72)	5.13	5.22	YR†
	8.6	McClellan	(72), *l*, (79)	5.37	5.36	
	10.9	Bohlin	(72) 2 N 8 (83)	5.73	5.61	
	13	Young	N = (72)	5.4	5.37	
	13.4	Wendell	Photometer	5.41		
	13.4	Daniel		5.30		
	14.5	Stebbins	*l* 2 N 2 (71)	5.20	5.19	
	16.0	Townley	N *l*	5.1		
2		Plassmann		4.55		
	7.1	Riccò	Photometer : ϵ	4.74	4.51	
	7.2	Müller A		4.7		*
	7.7	Harkányi	Photometer	4.47	4.32	
	7.8	Giovannozzi		4.4		
	8.5	Collette	½ (ν + *l*)	4.9	4.48	
	8.7	Bohlin	ν 4 N 2 ψ	4.45	4.15	
	8.8	Williams	About 1^m > (71)	4.4±	4.4	
	9.9	Bohlin	ν 5 N 5 *l*	4.57	4.48	
	12.3	Bohlin	ν 6 N 2 *l*	4.83	4.75	
	16.3	Townley	ν 5 *l*, κ 4 *l*	4.5	4.45	
	16.8	Aitken		4.7		
3		Plassmann	½ [(71) + (83)]	5.9	5.84	
		Sharp		5.8		
	7.7	Harkányi	Photometer	5.64	5.52	
	8.0	Giovannozzi	Uncertain	4.9		
	8.2	Meyermann	*l*. (72); very uncertain	5.25		
	8.3	Collette	< *l*	5.7		
	8.4	Epstein	*l* > (71) > (72) > N; (83) & (81) invisible in moonlight			
	8.5	Fauth		6.00	5.80	
	8.7	Bosc		5.52		
	8.8	Williams	(71) 1.5 N 9.5 (83)	5.55	5.49	
	9.0	Lockyer		5.7		
	9.4	Bohlin	*l* 4 N 3 (72)	5.47	5.18	
	13	Young	N = (72)	5.4	5.37	
	13.5	Jones	Poor	5.85:		
	13.8	Wendell	Photometer	5.63		
	14.0	Furness	*l* 3 N 2 (72)	5.3	5.28	
	14.2	Lockyer		6.0		
	14.5	Whitney	*l* 2 or 3 N	5.3	5.28	
	16.2	Aitken		5.4		
4	7.1	Riccò	Photometer : ϵ	6.16	5.94	
	8·0	Giovannozzi		5.5		
	8.2	Solà		6.6	5.8	
	8.3	Collette		6.1		
	8.3	Ambronn	(72) 2 N 1 (83)	6.13	6.02	
	8.3	Meyermann	(71), *l*, (72)	5.45		

* Color of σ. † κ bright yellowish; *l* and (72) white.

Date 1901	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised	Color
May	h					
4	8.5	Fauth		6.05	5.85	
	8.8	Williams	(71) 9 N 2 (83)	6.3	6.16	
	8.9	McClellan	(72), (85), (83), (79)	6.00	6.02	
	9.2	Wickham	(72) (90)	5.67	5.67	
	9.6	Bohlin	(72) 2 N	5.81	5.57	
	13.0	Hagen	(72) 10 N 20 (85)		5.87	
	13.3	Zwack	N 12 (85)		6.3	
	13.7	Daniel		5.77		
	16.3	Townley	(71) 7 (83); (72) 3-4 N	5.9	5.88	
	16.5	Aitken		6.0		
5	4.0	Stratanoff		5.87	5.68	
		Plassmann	½ [(71) + (83)]	5.9	5.84	
		Oertel	(71), (83)	6.3		
	7.1	Riccò	Photometer : ϵ	5.88	5.65	
	7.2	Müller A	(71)	5.3		
	7.6	Sviatsky		5.8		
	7.6	Harkányi	Photometer	5.75	5.64	
	8.0	Giovannozzi		5.6		
	8.2	Ambronn	(72) 2 N 1 (83); (71) 2 N 1 (83)	6.12	6.02	
	8.5	Schwab	(72) 2 N 2 (83)		5.86	
	8.6	Williams	(71) 8 N 3 (83)	6.2	6.07	
		Butler		5.6		
	13.4	Daniel		5.95		
	16	Aitken		6.0		
6	4.1	Stratanoff		5,75	5.57	
		Balassny	N = (72)	6.5?	5.37	
	8.6	Williams	(71) 10 N 1 (83)	6.4	6.27	
	8.8	Collette		6.1		
	9.1	Robinson	(72), (79)	5.70	5.60	
	9.1	McClellan	(72), (79)	5.70	5.60	VR
	9.2	Bohlin	(72), 6 N	6.12	5.97	
	13	Young	N = (72)	5.4	5.37	
	13.4	Daniel		6.16		
	13.5	Jones		5.80		
	14.0	Furness	*l* 2 or 3 N 2 (72)	5.3	5.22	
	16	Aitken		5.8		
7	8.2	Solá		5.4	4.9	
	8.2	Collette	> *l*	5.0		
	8.5	Ambronn	ν 3 N 1 *l*; ν 2 N 1 (72)	4.85	4.82	
	8.5	Meyermann	ν, *l*, (72)	4.85		
	8.5	Fauth		5.50	5.33	
	9.3	Bohlin	ψ 2 N 4 *l*	4.81	4.55	
	10.0	Bohlin	ψ 5 N 2 *l*	4.98	4.81	
	13.2	Jones		4.92		
	13.2	Furness	κ 2 N 3 or 4 *l*; ν 3 N	4.5	4.37	
	13.8	Furness	κ 2 N 4 or 5 *l*	4.5	4.33	
	16	Aitken		4.4		
	16.3	Townley	ν 3 *l*; κ 2-3 *l*	4.3	4.26	
8		Plassmann	½ (κ + *l*)	4.6	4.52	
		Balassny	N = (71)		5.35	
	7.1	Riccò	Photometer : ϵ	4.96	4.73	
	7.2	Müller A	σ	4.5		
	7.4	Sviatsky		5.1		
	7.4	Harkányi	Photometer	4.66	4.51	
	9.0	Fauth		4.80	4.68	
	9.1	Epstein	N > (71) > *l* > (81) > (83)	> 5.0		
	13.1	Wendell	Photometer	5.06		

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude.		Color
				Obs'r.	Revised.	
May	h					
8	13.2	Jones		5.35		
	16	Aitken		5.3		
9		Balassny	N = (72)		5.37	
		Plassmann	½ [(71) + (83)]	5.9	5.84	
		Oertel	(71), (83)	< 6.0		
	6.9	Riccò	Photometer : ϵ	5.99	5.76	
	7.0	Müller A	(71), (85)	6.0		*
	7.7	Sviatsky		5.7		
	8.2	Solá		6.7	5.6	
	8.5	Schwab	(72) 2 N 2 (83)		5.86	
	10.1	Bohlin	(72) 4 N 8 (83)	5.78	5.70	
	13.5	Epstein	(72) = > *l* > (72) = (81) > > N > (83)		6.29	
	16	Aitken		5.8		
	16.3	Townley	(71) 7 (83)	6.1	6.05	
10		Balassny	(72) 0m.2 N		5.6	
	7.4	Sviatsky		5.7		
	8.2	Solá		6.2±	5.3:	
	9.3	Collette	< *l*	6.1		
	9.9	Bohlin	(72) 2 N 8 (83)	5.73	5.57	
	10.8	Bohlin	(72) 4 N 10 (83)	5.76	5.65	
	16	Aitken		6.0		
11		Balassny	(72) 0m.5 N		5.9	
	8.7	Solá		5.0±		
	9.0	Robinson	(79)	6.10	5.94	O†
	9.1	McClellan	(79)	6.00	5.84	VR
	9.3	Collette		< 6.0		
	15.8	Aitken		6.0		
	16.3	Townley	(71) 5 (83)	5.9	5.86	
12		Balassny	N = *l*		5.03	
		Plassmann	½ [(71) + (83)]	5.9	5.84	
		Oertel	(72), (71)	5.6		
		Epstein	N = (71) = (72) > *l*		5.36	
	8.2	Schwab	*l* 1 N 2 (72)		5.15	
	8.8	Schwab	N 1 *l*		4.9	
	9.5	Bohlin	*l* 6 N 2½ (72)	5.49	5.29	
	9.8	Williams	N 2 (83); N 12 (85)	6.3	6.06	
	9.9	Wickham	(72), *l*, (90), (79), (71)	5.36	5.26	LR‡
	10.0	Schwab	N 1 *l*		4.9	
	10.0	McClellan	*l*, 30	5.05	5.15	
	10.1	Robinson	*l*	5.00	5.19	
	10.2	Schwab	(71) 2 N 2 *l*		5.2	
	15.5	Solá		6.7±	5.6:	
	16.0	Stebbins	N (*l*, 71) through clouds	5.2	5.19	
	16.3	Townley	N (71)	5.3	5.35	
	16.5	Aitken		5.7		
13		Balassny	*k* 0.1m N	5.1	5.2	
	8.5	Schwab	N = (71)		5.35	
	8.5	Giovannozzi		4.6		
	8.6	Robinson	*l*, ν	4.40	4.46	¶
	8.8	Fauth		5.68	5.50	
	8.8	Meyermann	ν, *l*, (72)	4.80		
	9.0	Plassmann	½ (κ + *l*)	4.65	4.52	
	9	Epstein	N > *l*	> 5.0		
	9.2	Collette	½ (ν + *l*)	4.9	4.48	

* Color of σ. † Orange with red fringe. ‡ Much fainter red than for a month.
¶ Large central yellow disc, with red wings; ν is yellowish.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised	Color
May						
13	9.3	Williams	(71) 0.3 N 11 (83)	5.4	5.38	
	10.0	Bohlin	ψ 5 N 2 *l*	4.97	4.81	
	10.0	Wickham	*l*, σ, κ	4.60	4.73	*
	11.3	Plassmann	$\frac{1}{2}(\kappa + l)$	4.65	4.52	
	12.1	Bohlin	ψ 3 N 3 *l*	4.88	4.65	
	13.6	Epstein	$l = (71) > N = > (72) > (81) > > (83)$		5.36	
	16.2	Aitken		5.5		
14		Balassny	$N = l$		5.03	
	8	Meyermann	*l*, (72)	5.3		
	8.5	Schwab	(71) 3 N 2 (83)		5.94	
	8.5	Giovannozzi		5.3		
	8.5	Fauth		6.20	6.00	
	8.7	Epstein	$(71) = > l > N = (72)$		5.37	
	8.8	Ambronn	*l* 2 N 1 (73)	6.03	5.90	
	8.9	Plassmann		6.05		
	9.0	Fauth		6.18	5.98	
	9.2	Collette		6.0		
	9.4	Williams	(71) 8 N 2.7 (83)	6.2	6.06	
	9.9	McClellan	(72), (79)	5.55	5.47	
	10.0	Robinson	*l*	5.1:	5.29	
	10.4	Bohlin	*l* 4 N 2 (72)	5.47	5.26	
	13.5	Epstein	$(71) > l = > (72) > (81) > > N > (83)$		6.29	
	16.3	Aitken		5.7		
15	7.0	Müller A	(85)	6.5		
	8.5	Robinson	(72), (79)	6.00	5.92	†
	9.5	Williams	(83) 1 N 9 (85)	6.6	6.40	
	9.6	Collette		6.2		
	9.9	Bohlin	(72) 4 N 2 (83); (71) 3 N 2 (83)	6.18	5.98	
	16.4	Aitken		6.0		
16	7.2	Müller A		6.0		
	10.0	McClellan	(72) (79)	5.90	5.82	VR
	10.2	Robinson	(72) (79)	5.90	5.82	R
	16	Aitken		5.8		
17	9.2	Williams	(71) 4 N 7 (83)	5.8	5.71	
	9.4	Collette	$= l$	5.5	5.03	
	9.8	Williams	(71) 5 N 6 (83)	5.9	5.80	
	10.2	Robinson	(72), (79)	5.00	4 92	
	13 7	Epstein	$(71) > (72) = l > N > (81) > > (83)$		5.4	
	15.8	Aitken		4.75		
18		Fauth		5.65	5.47	
	8.3	Robinson	ν	4.80	4.73	
	9.2	Collette	$> l$	5.1	> 5.0	
	9.2	Epstein	$(71) > N > > (81) > > (83)$		5.6	
	9.5	Williams	(71) 4 N 7 (83)	5.8	5.72	
	9.8	Williams	(71) 5 N 6 (83)	5.9	5.80	
	10.0	McClellan	*l*	4.50	4.69	
	10.5	Plassmann		5.93		
	11.5	Bohlin	ψ 5½ N 1 *l*	5.04	4.89	
	12 9	Plassmann		5.93		
	13.9	Epstein	$(71) = l > N > (72) > > (81) > > (83)$		5.28	
19		Plassmann		6.05		
	9.2	Collette		6.1		

* Absence of red tint. † Redness more apparent.

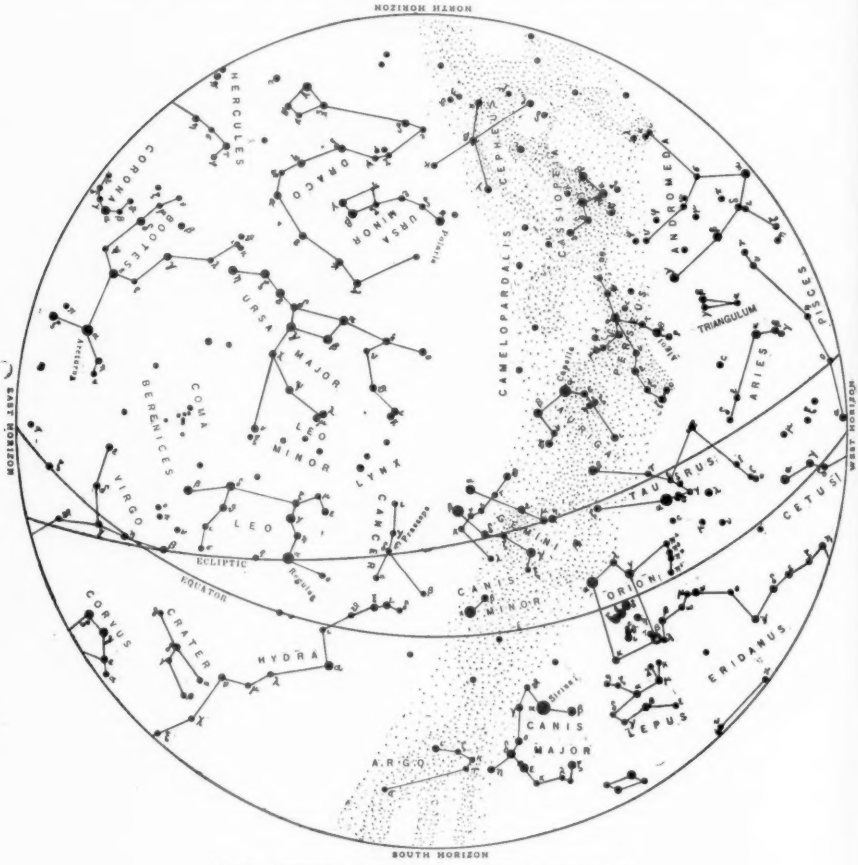
Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised	Color
May	h					
	9.8	Bohlin	(71) 5 N 2 (83)	6.24	6.06	
	16	Aitken		6.10		
20	7.2	Müller A	(71)	6.0		
		Plassmann		6.02	6.65	
	9.0	Fauth		6.90		
	9.1	Ambronn	(72) 1 N 2 (83)	5.77	5.69	
	9.2	Williams	(71) 8 N 3 (83)	6.2	6.04	
	9.4	Williams	(71) 9 N 2 (83); N 9 (85)	6.2	6.15	
	9.6	Williams	(71) 11 N = (83); N 9 (85)	6.3	6.25	
	9.8	Bohlin	(71) 4 N 3 (83)	6.10	5.92	
	9.8	McClellan	(72) (79)	5.70	5.62	VR
	9.8	Robinson	(72)	5.65	5.57	R
	13.1	Epstein	(71) > *l* > (72) >> (81) > N > (83)		6.27	
21		Plassmann		6.06		
	8.8	Schwab	N = (83)		6.34	
	9.0	Fauth		6.18	5.98	
	9.0	Meyermann	(71) (83)	6.1		
	9.2	Ambronn	(72) 2 N 1 (83); (71) 2 N 1 (83)	6.12	6.02	
	9.2	Williams	(71) 9 N 2 (83)	6.3	6.16	
	9.4	Williams	(71) 10 N 2 (83); N 9 (85)	6.2	6.17	
	9.5	Williams	(71) 11 N 1 (83); N 9 (85)	6.3	6.23	
	9.7	Williams	(71) 10 N = (83); N 10 (85)	6.3	6.20	
	9.9	McClellan	(72), (79)	6.05	5.97	R*
	10.5	Bohlin	(71) 4 N 1 (83)	6.32	6.14	
	13.2	Epstein	N = or < (81); (71) = > *l* > (72) >> (81) = > N > > (83)		6.2	
22	7.2	Müller A	(71)	5.0		
		Plassmann		4.96		
	8.5	Schwab	N = (71)		5.31	
	8.8	Fauth		5.62	5.44	
	9.3	Williams	(71) 1 N 11 (83)	5.45	5.43	
	9.6	Williams	N 5 (71)	4.9	4.95	
	9.7	Williams	N 4 (71)	5.0	5.03	
	9.8	Williams	N 2 (71)	5.2	5.19	
	9.8	Meyermann	*ν*, *l*, (72)	4.80		
	11.1	Robinson	*ν*, *l*, *κ*	4.40	4.46	
	13.6	Epstein	N = > *l* = (71) > (72) >> (81) >> (83)		5.0	
	14.2	Epstein	N > *l* > (71) > (72). Nearly equal.		5.0	
	14.5	Giovannozzi		4.8		
23	9.3	Fauth		6.26	6.05	
	9.3	Williams	(71) 6 N 5 (83)	6.0	5.89	
	9.6	Williams	(71) 9 N 3 (83)	6.25	6.10	
	9.7	Williams	(71) 9 N 2 (83)	6.3	6.16	
	9.8	Robinson	(72), (79)	5.70	5.62	
	9.8	Meyermann	(71), (83)	6.0		
	9.9	Bohlin	(71) 4 N 4 (83)	6.03	5.85	
	10.1	Plassmann		5.89		
	12.1	Plassmann		5.89		
	23.5	Aitken		6.05		
24	9.5	Williams	N 5 (83)	6.0	5.89	
	9.6	Williams	(71) 8 N 3 (83)	6.2	6.07	
	9.6	Fauth		6.21		
	9.8	Robinson	(72), (79), (83) (82)	5.88	5.91	R

* *κ* reddish yellow.

PLANET NOTES FOR MARCH.

H. C. WILSON.

Mercury will be morning star during March, reaching greatest western elongation, 27° 40′, on the morning of the 17th. The planet was quite conspicuous as evening star near Venus during the first days of February and the relative



THE CONSTELLATIONS AT 9 P. M. MARCH 1902.

movements of the two planets were watched with a great deal of interest by many students.

Venus also will be morning star, and will be very conspicuous in the southeast just before sunrise, during this month. Her greatest brilliancy will be attained about March 21. Venus, Mercury and the waning Moon will form a

brilliant and pleasing group on the mornings of the 7th and the 8th, the conjunction of the Moon with Venus occurring about noon and that with Mercury about midnight of the 7th.

Mars is behind the Sun and therefore invisible. Conjunction will occur on March 29.

Jupiter and *Saturn* are also to be seen in the morning. They will be found toward the southeast a couple of hours before sunrise in the constellation Sagittarius. The Moon will pass Saturn on the 5th and Jupiter on the 6th of March.

Uranus will be at quadrature, 90° west from the Sun, March 12 and so is to be found near the meridian at sunrise. Its place is in Scorpio as shown upon the chart in the January number of POPULAR ASTRONOMY.

Neptune will be at quadrature, 90° east from the Sun, at midnight March 19, and so may be observed in the early evening. This is the only evening planet now visible. The position of the planet Mar. 1 is R. A. $5^h\ 54^m\ 21^s$; Decl. $+\ 22°\ 17'$, and it is nearly stationary during the month.

The Moon.

Phases.		Rises. (Central Standard Time at Northfield Local Time 13m less.)	Sets.
		h m	h m
Mar. 2	Last Quarter	1 30 A. M.	11 04 A. M.
9	New Moon	6 04 "	6 05 P. M.
16-17	First Quarter	10 44 "	2 02 A. M.
23-24	Full Moon	6 22 P. M.	6 10 "
Apr. 1	Last Quarter	12 59 A. M.	10 35 "

Occultations Visible at Washington.

Date. 1901.	Star's Name.	Magnitude.	IMMERSION. Washington M.T.	IMMERSION. Angle f'm N pt.	EMERSION. Washington M. T.	EMERSION. Angle f'm N pt.	Duration
			h m	°	h m	°	h m
Mar. 1	B.A.C. 5580	5.7	14 24	88	15 42	297	1 18
4	ρ^1 Sagittarii	3.9	18 37	46	19 51	293	1 15
13	σ Arietis	5.5	7 34	118	8 24	224	0 50
15	i Tauri	5.2	7 24	120	8 29	243	1 05
19	A^1 Cancri	5.6	6 16	59	7 10	336	0 53
19	A^2 Cancri	5.8	8 43	115	10 06	290	1 23
21	36 Sextantis	6.6	17 24	111	18 15	285	0 52

COMET AND ASTEROID NOTES.

Comet 1845 II.—In *A. N.* 3763 Dr. A. Scheller gives a determination of the orbit elements of this comet, from all of the published observations in 1845. The observations were combined into eight normal positions. Elliptic elements make the semi-major axis 2368 times the Earth's distance from the Sun and the period 115,206 years. The observations are equally well satisfied by the following parabolic elements, which may be considered definitive:

EPOCH OF OSCULATION 1845, APRIL 17.5.

$$T = 1845 \text{ April } 21.046902 \pm 0.0016054, \text{ Paris mean time.}$$
$$\left.\begin{aligned} \pi &= 192°\ 34'\ 10''.08 \pm 8''.70 \\ \Omega &= 347\ \ 06\ \ 55\ .12 \pm 3\ .65 \\ i &= \ 56\ \ 23\ \ 01\ .24 \pm 3\ .69 \end{aligned}\right\} 1845.0$$
$$\log q = 0.0984876 \pm 0.0000140.$$

Comet 1901, I.—In *A. N.* 3763 Mr. A. A. Nijland gives a number of observations of the tail of the great comet of 1901, illustrated by two drawings made on May 5 and 18.

New Asteroids.—The following new asteroids have been discovered since November last:

	Discovered by	at	Local M. T.	R. A.	Decl.	Mag.
			h m	h m	° ′	
1901 HL	Wolf	Heidelberg	Dec. 4	9 55.9	5 01.9	+16 58	11
HM	Kopff	Heidelberg	5	6 52.0	22 22.1	− 0 28	...

Elements of Asteroid (265) Anna.—In *A. N.* 3761 Dr. Berberich gives elements of this planet depending upon the observations obtained at three oppositions of 1887, 1888 and 1899. The orbit of this planet has a great inclination to the equator, which is exceeded only by that of (247) Eukrate, and observations of it are therefore desired. The magnitude at opposition is about 13^m.

ELEMENTS.

Epoch 1902 Feb. 23.0 Berlin M. T.

$M = 307°\ 47'\ 51''.0$
$\omega = 251\ 12\ 11\ .1$
$\Omega = 335\ 23\ 16\ .7$ 1900.0
$i = 25\ 42\ 10\ .3$

$\phi = 15°\ 11'\ 57''.7$
$\mu = 941''.0735$
$\log a = 0.3842544$

EPHEMERIS.

	R. A. app.	Decl. app.	log Δ	Aber.	Time.
	h m s	° ′ ″		h	m
Mar. 1	9 33 46.26	+20 30 14.8	0.07658	9	55
2	32 15.58	20 20 43.8	07703		55
3	30 46.40	20 11 01.6	07757		56
4	29 18.81	20 01 08.6	07821		57
5	27 52.92	19 51 05.2	07894		58
6	26 28.82	19 40 51.8	07976	9	59
7	25 06.60	19 30 28.7	08068	10	00
8	23 46.36	19 19 56.3	08168		01
9	22 28.17	19 09 15.2	08277		03
10	21 12.11	18 58 25.6	08394		05
11	19 58.25	18 47 28.1	08518		07
12	18 46.66	18 36 22.9	08650		09
13	17 37.40	18 25 10.6	08791		11
14	16 30.53	18 13 51.5	08939		13
15	9 15 26.08	+18 02 26.0	0.089093	10	15

Elements and Ephemeris of Asteriod (347) Pariana.—In *A. N.* 3760 Mr. G. Boccardi of the Observatory of Catania, gives elements and ephemeris of the planet (347) Pariana for the opposition of 1902. The actual opposition occurred Feb. 5 and the magnitude of the planet was then 11.1. The portion of the ephemeris for March is given below.

ELEMENTS.

Epoch 1902 February 23.5 Berlin M. T.

$M = 338°\ 22'\ 44''.8$
$\pi = 169\ 17\ 16\ .5$
$\Omega = 85\ 56\ 14\ .5$ 1900.0
$i = 11\ 41\ 59\ .1$

$\phi = 9°\ 33'\ 30''.5$
$\mu = 840''.3466$
$\log a = 0.417032$

EPHEMERIS.

1902	R. A. (true) h m s	Decl. (true) ° ′ ″	log r	log Δ
Mar. 1	8 48 51.98	+ 34 14 37.6	0.34565	0.13057
2	48 19.47	34 15 47.7		
3	47 48.92	34 16 41.1	0.34532	0.13433
4	47 20.39	34 17 18.0		
5	46 53.89	34 17 38.7	0.34499	0.13827
6	46 29.46	34 17 43.6		
7	46 7.13	34 17 32.8	0.34468	0.14240
8	45 46.94	34 17 6.4		
9	45 28.90	34 16 24.7	0.34437	0.14668
10	45 13.01	34 15 28.4		
11	44 59.31	34 14 17.5	0.34406	0.15112
12	44 47.86	34 12 52.0		
13	44 38.62	34 11 12.6	0.34377	0.15569
14	44 31.56	34 9 19.9		
15	44 26.70	34 7 13.9	0.34348	0.16036
16	44 24.08	34 4 54.8		
17	44 23.68	34 2 22.9	0.34320	0.16514
18	44 25 50	33 59 38.8		
19	44 29.49	33 56 42.7	0.34292	0.17001
20	44 35.61	33 53 34.4		
21	44 43.89	33 50 14.7	0.34266	0.17496
22	44 54.35	33 46 44.2		
23	45 6.94	33 43 2.6	0.34239	0.17997
24	45 21.61	33 39 9.9		
25	45 38.36	33 35 6.6	0.34214	0.18504
26	45 57.16	33 30 53.2		
27	46 17.99	33 26 29.7	0.34190	0.19015
28	46 40.83	33 21 56.5		
29	47 5.65	33 17 13.5	0.34166	0.19530
30	47 32.43	33 12 21.0		
31	8 48 1.16	+ 33 7 19.2	0.34143	0.20048

VARIABLE STARS.

Nova Persei.—The translation of Professor Kayteyn's article to which we referred last month was crowded out, unknown to the writer of this note, but is given in this number, so that some of the statements then made will now be more intelligible. The same explanation of the nebula around the nova was independently suggested by Mr. W. E. Wilson, of Daramona, Ireland. He says that the distance of the star on this supposition may be 313 light years.

The nova is now about 8.0 mag., just at the limit of visibility with opera-glasses.

The Variable β Lyræ.—In *Bulletin de la Société Astronomique de France* for January, 1902, Mr. J. M. Péridier gives a considerable number of observations of this variable and discusses the character of the light variations. The most remarkable point is the retardation of the principal minimum as compared with the maxima. He thinks that the formula of Pannekoek (*A. N.* 3456) gives the best representation of the observed times of the principal minimum:

$$1855, \text{Jan. } 6.610 + 12.908009E + 0.000003855E^2 - 0.00000000047E^3.$$

According to the light curve drawn by Mr. Péridier the first maximum occurs 3 days 6 hours, the second minimum 7 days 2 hours, the second maximum about 10 days 2 hours after the principal minimum. The magnitude of the variable at both maxima is 3.2, at the principal minimum about 4.1 and at the secondary minimum 3.8.

Minima of Variable Stars of the Algol Type.

[Greenwich Mean Time beginning with midnight. The hours greater than 12 are those of the afternoon. To obtain Eastern Standard time subtract 5 hours; for Central Standard subtract 6 hours.]

U Cephei.

d	h
Mar. 4	2
6	14
9	2
11	14
14	1
16	13
19	1
21	13
24	1
26	13
29	0
31	12

Algol.

Mar. 1	11
4	8
7	5
10	1
12	22
15	19
18	16
21	13
24	10
27	6
30	3

λ Tauri.

Mar. 6	1
10	0
13	23
17	22
21	20
25	19
29	18

R Canis Maj.

Mar. 1	17
2	20
3	23
5	2
6	6
7	9
8	12
9	15
10	19
11	22
12	1
14	5
15	8
16	11
17	14
18	18
19	21
21	0
22	3
23	7

R Can. Maj. Cont.

d	h
Mar. 24	10
25	13
26	16
27	20
28	23
30	2
31	5

S Cancri.

Mar. 7	1
16	13
26	0

S Antliæ.

Period $7^h\ 46^m.8$

Mar. 1	9
2	8
3	8
4	7
5	6
6	6
7	5
8	4
9	4
10	3
11	2
12	2
13	1
14	0
15	0
15	23
16	22
17	22
18	21
19	20
20	20
21	19
22	18
23	18
24	17
25	16
26	16
27	15
28	14
29	14
30	13
31	12
1	7
3	15
5	23
8	6
10	14
12	22
15	6

δ Libræ.

h	d
Mar. 17	14
19	22
22	6
24	13
26	21
29	5
31	13

U Coronæ.

Mar. 3	19
7	6
10	16
14	3
17	14
21	1
24	12
27	23
31	10

U Ophiuchi.

Mar. 1	16
2	12
3	8
4	4
5	1
5	21
6	17
7	13
8	9
9	5
10	1
10	21
11	18
12	14
13	10
14	6
15	2
15	22
16	18
17	14
18	11
19	7
20	3
20	23
21	19
22	15
23	11
24	7
25	4
26	0
26	20
27	16
28	12
29	8

U Ophiuchi Cont.

d	h
Mar. 30	4
31	0
31	21

Z Herculis.

Mar. 2	21
4	22
6	21
8	22
10	21
12	21
14	20
16	21
18	20
20	21
22	20
24	21
26	20
28	21
30	20

RX Herculis.

Mar. 1	6
2	3
3	1
3	22
4	19
5	17
6	14
7	11
8	9
9	6
10	3
11	1
11	22
12	19
13	17
14	14
15	11
16	9
17	6
18	3
19	1
19	22
20	19
21	17
22	14
23	11
24	9
25	6
26	4
27	1
27	22

RX Herculis Cont.

d	h
Mar. 28	20
29	17
30	14
31	12

V[3] Cygni

Mar. 1	7
7	7
13	7
19	7
25	8
31	8

U[3] Cygni.

Mar. 2	21
7	11
12	0
16	14
21	4
25	18
30	7

W Delphini.

Mar. 5	11
10	6
15	2
19	21
24	16
29	12

Y Cygni.

Mar. 2	14
3	6
4	14
6	6
7	14
9	6
10	14
12	5
13	13
15	5
16	13
18	5
19	13
21	5
22	13
24	5
25	13
27	5
28	13
30	5
31	13

Variable Stars of Short Period not of the Algol Type.

	Minimum.		Maximum.			Minimum.		Maximum	
		h		h			h		h
β Lyrae	Mar. 1	0	Mar. 4	9	W Sagittarii	Mar. 17	3	Mar. 20	3
Y Ophiuchi	1	18	7	23	W Virginis	17	15	25	19
W Sagittarii	1	23	4	23	W Geminorum	18	4	20	19
δ Cephei	2	2	3	17	δ Cephei	18	5	19	20
W Geminorum	2	17	5	8	T Vulpeculae	18	13	19	22
T Monocerotis	3	0	10	22	Y Ophiuchi	18	21	25	2
S Sagittae	3	20	7	6	β Lyrae	20	9	23	11
Y Sagittarii	5	3	6	22	S Sagittae	20	15	24	1
T Vulpeculae	5	6	6	15	U Sagittarii	20	18	23	17
ζ Geminorum	5	13	10	13	U Aquilae	20	20	23	0
η Aquilae	6	20	9	2	η Aquilae	21	4	23	10
U Aquilae	6	19	8	23	X Sagittarii	21	22	24	19
U Sagittarii	7	6	10	5	Y Sagittarii	22	11	24	6
δ Cephei	7	11	9	1	T Vulpeculae	22	23	24	8
β Lyrae	7	11	10	13	δ Cephei	23	14	25	5
X Sagittarii	7	21	10	18	W Sagittarii	24	17	27	17
W Sagittarii	9	13	12	13	ζ Geminorum	25	20	30	20
T Vulpeculae	9	16	11	1	W Geminorum	25	22	28	13
W Geminorum	10	10	13	1	β Lyrae	26	20	30	5
Y Sagittarii	10	22	12	17	T Vulpeculae	27	10	28	19
S Sagittae	12	5	15	15	U Sagittarii	27	12	30	11
X Cygni	12	5	19	0	U Aquilae	27	20	30	0
δ Cephei	12	20	14	11	Y Sagittarii	28	6	30	1
U Aquilae	13	19	15	23	η Aquilae	28	8	30	14
β Lyrae	13	22	17	7	X Cygni	28	14	Apr. 3	9
η Aquilae	14	0	16	6	X Sagittarii	28	22	31	19
U Sagittarii	14	0	16	23	δ Cephei	28	22	30	13
T Vulpeculae	14	2	15	11	S Sagittae	29	0	Apr. 1	10
X Sagittarii	14	22	17	19	T Monocerotis	30	0	6	22
ζ Geminorum	15	17	20	17	T Vulpeculae	31	20	2	5
Y Sagittarii	16	17	18	12					

Maxima and Minima of Long Period Variables.

[Computed from Chandler's "Third Catalogue" by Misses Ida I. Watson and Helen M. Swartz of Vassar College Observatory.]

Maxima.			Maxima.			Minima.		
Date Mar.	No.	Star.	Date Mar.	No.	Star.	Date Mar.	No	Star.
9	7754	W Cygni	26	5675	V Coronae	5	5795	W Scorpii
10	103	T Andromedæ	28	6923	Z Sagittarii	8	845	R Ceti
10	4596	U Virginis	29	7659	T Capricorni	8	7220	S Cygni
10	5194	V Bootis	30	6044	S Herculis	10	5338	U Bootis
11	2013	U Aurigae	31	466	U Piscium	14	7431	S Delphini
13	7118	X Aquilae	31	5831	S Scorpii	15	4557	S Ursæ Maj.
16	2266	V Monocero.	31	7450	V Aquarii	22	2539	R Canis Min.
17	7577	X Capricorni	31	7783	RU Cygni	22	3477	R Leonis Min.
20	4377	T Virginis				22	7242	S Aquilæ
21	2684	S Canis Min.		Minima.		23	5237	R Bootis
21	5070	Z Virginis	2	782	R Arietis	26	5677	R Serpentis
21	5174	RS Virginis	4	7045	R Cygni	27	7120	X Cygni
22	5511	RS Libræ	5	715	S Arietis	28	3994	S Leonis
						31	5950	W Herculis

Schwab's New Variable 93,1901.—Two telegrams have been received concerning this variable, the first from Professor Kreutz, of Kiel, Germany, announcing that a minimum of Schwab's new Algol-type variable would occur Feb. 3.89 Greenwich mean time and that the period is 3.38 days. The second

states that the variable was found by Mr. J. A. Parkhurst, of Yerkes Observatory, to be of magnitude 8.45 at $23^h\ 46^m$ Gr. M. T. on Feb. 3, and of magnitude 8.10 at $0^h\ 29^m$ Gr. M. T. on Feb. 4.

In a circular, issued from Harvard College Observatory, Feb. 4, it is stated that the minimum was observed both visually and photographically on Feb. 3 at that Observatory, by Mr. Colson. The observations extended from $21^h\ 51^m$ to $22^h\ 34^m$ Gr. M. T.

The variable may be observed best between 5 and 6 o'clock in the morning, being seen toward the east at that time in the constellation Sagitta in R. A. $19^h\ 14^m$ and Decl. $+19°\ 25'$. Its ordinary brightness is about $6^m.5$, requiring the use of a small telescope for observation.

According to the data given the minima for March will be as follows:

Greenwich M. T.		Greenwich Civil Time.		Central Standard Time.	
d	h	d	h	d	h
Mar. 2	22	Mar. 3	10	Mar. 3	4 A. M.
6	7	6	19	6	1 P. M.
9	17	10	5	9	11 "
13	2	13	14	13	8 A. M.
16	11	16	23	16	5 P. M.
19	20	20	8	20	2 A. M.
23	5	23	17	23	11 "
26	14	27	2	26	8 P. M.
29	23	30	11	30	5 A. M.

Observations of Nova Persei.

Y M D	E. S. T. h	m	J Day	Comparison	Mag.
1901 12 4	7	20	2415723	*h* 2 V 1½ *k*	7.10
" " 10	7	0	29	*h* 1½ V 1½ *k*	7.08
" " 11	8	40	30	*h* 1½ V 1½ *k*	7.08
" " 15	6	55	34	*h* 1½ V 1½ *k*	7.08
" " 21	6	30	40	*h* 2 V 1½ *k*	7.10
" " 24	7	25	43	*h* 2½ V 1 *k*	7.15
" " 30	11	10	49	*h* 2½ V 1 *k*	7.15
1902 1 1	7	5	51	*h* 2 V 1 *k*	7.13
" " 4	10	45	54	*h* 2 V 1½ *k*	7.10
" " 5	10	10	55	*h* 2½ V 1 *k*	7.15
" " 12	8	50	62	*h* 2 V 1 *k*	7.13
" " 13	9	45	63	*h* 2½ V ½ *k*	7.19

PROVIDENCE, Jan. 14th, 1902. F. E. SEAGRAVE.

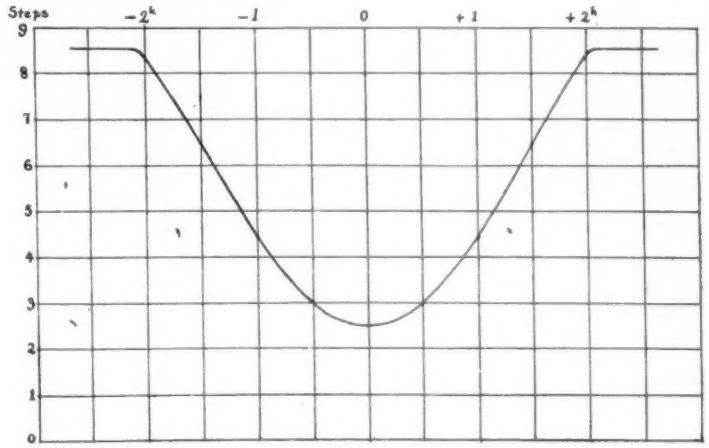
The stars *h* and *k* are Nos. 85 and 87 of the list in the Oct. No. of POPULAR ASTRONOMY, p. 454. H. C. W.

Variable Star RX Herculis.—This variable was discovered by Edwin F. Sawyer in 1898, and is of the Algol type. Its variation is from 7.0^m to 7.5^m, the period being $21^h\ 20^m\ 33^s$. The light is constant for $17^h\ 12^m$, drops about a half magnitude in an hour and a half, is nearly constant for an hour and recovers in an hour and a half, the diminution of light occupying thus about 4^h. In *A. N.* 3764 Mr. M. Luizet, of Lyons, gives a new determination of the elements of this variable from 390 observations made by him during the years 1899, 1900 and 1901. The elements are:

Min.: 1898 Oct. 3 $13^h\ 10^m$ (Paris M. T.) + $21^h\ 20^m\ 32^s.9$ E,
or 2414566,549 J. D. + 0.88927 E.

Mr. Luizet gives a light curve of the star and an ephemeris for 1902, which we will give monthly with those of the other Algol variables.

The following list of comparison stars gives the light scale used by Luizet and may be useful to other observers:

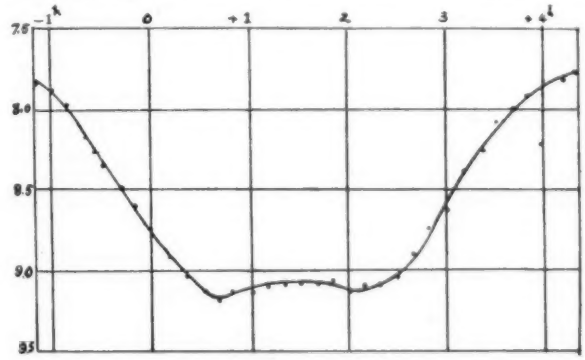


THE LIGHT CURVE OF RX HERCULIS.

	BD.	L.	BD.	Sawyer.	Potsdam.	Harvard.
	°		m	m	m	m
A = +	10.3532	11.9	6.8	—	7.12	6.80
a = +	13.3658	8.3	6.8	7.27	7.12	6.89
b = +	13.3677	6.0	6.8	7.47	7.36	7.18
c = +	12.3598	5.5	7.0	7.58	7.48	7.35
e = +	12.3546	0.0	7.7	—	—	—

The place of the variable for 1900 is $18^h\ 26^m\ 02^s$; Decl. + 12° 32′.6.

Light Curve of U Cephei.—In *A. N.* 3762 Mr. K. Bohlin of the Observatory of Stockholm gives a light-curve of U Cephei constructed from his own



THE LIGHT CURVE OF U CEPHEI.

observations in 1896. The form of the curve agrees closely with those determined by Chandler, *A. J.* XIX p. 49 and by Wilsing *A. N.* 2596. Mr. Bohlin finds for the period of the variable from his observations $2^d\ 11^h\ 49^m\ 44^s.5$.

GENERAL NOTES.

So many observations of the November Leonids have come to hand that we have not yet been able to publish all of them. A few more will be given next month.

Harvard Gift to Professor Pickering.—The staff of the Harvard College Observatory yesterday presented Professor E. C. Pickering with a handsome silver loving cup, in recognition of his twenty-five years' service as director. For his contributions to science Professor Pickering holds two gold medals from the Royal Astronomical Society of Great Britain and the Rumford and Draper medals, awarded in this country.

Remarkable Nebulæ.—During the several years in which I was engaged in the discovery of new nebulæ, I often found those that seemed to possess some peculiarity deserving of more critical examination than could at the time be give n to them, so I laid them aside for future observation.

The following is a partial of them, which from failing sight I was unable to re-examine.

It is my desire that they be examined with more powerful instruments, and by different observers. Dr. Barnard has promised to do so, but he is a busy man, and some time may elapse before he can find time to do so to all of them.

No. 1	R. A.	0^h	46^m	45^s	$+33°$	0′.7
" 2	"	1	45	45	+30	36 .3
" 3	"	19	22	0	+36	24 .0

At first sight the above appear like double stars some 5″ apart, but on closer examination with higher powers, each were found to be a round stellar nebulous disk, appearing like a double nebulous Uranus.

No. 4	R. A.	10^h	24^m	30^s	$+35°$	3′.4
" 5	"	10	35	12	+35	31 .6
" 6	"	13	31	10	+33	3 .6

These three objects at first sight appear like numbers 1, 2, 3, but when examined with higher powers, only one component of each pair was found to be a nebula, the other a star.

No. 7	R. A.	3^h	31^m	0^s	$+34°$	47′.0
" 8	"	5	29	20	+36	28 .5

These are hair-line nebulæ, one of them however with high magnification was found to be very slightly broadened at the middle, while the other was of equal width throughout its entire length. They are doubtless thin disks, perhaps rings, seen edgewise parallel to our line of sight.

No. 9 R. A. 13^h 51^m 35^s $+39°$ 31′.8.

This is a beautiful nebulous star of the 8th mag. exactly in the center of a nebulous atmosphere, whose outlines are as sharp as the planet Jupiter.

The dates of the above discoveries I am unable to give now, as my observation book is with my son Edward, at Buffalo. When however, they were found, I could find no previous observation of them, and I therefore entered them as Novæ.

LEWIS SWIFT.

MARATHON, N. Y., Feb. 3, 1902.

Observations of Leonids 1901, at University of Minnesota.—The sky was clear during the four nights of observation, but no serious attempt was made to count the meteors on Nov. 13 and 17, as they were so few in number. On Nov. 14 only one observer was on duty at a time, but he was relieved at frequent intervals. Attention was directed to the sky in the vicinity of the rad-

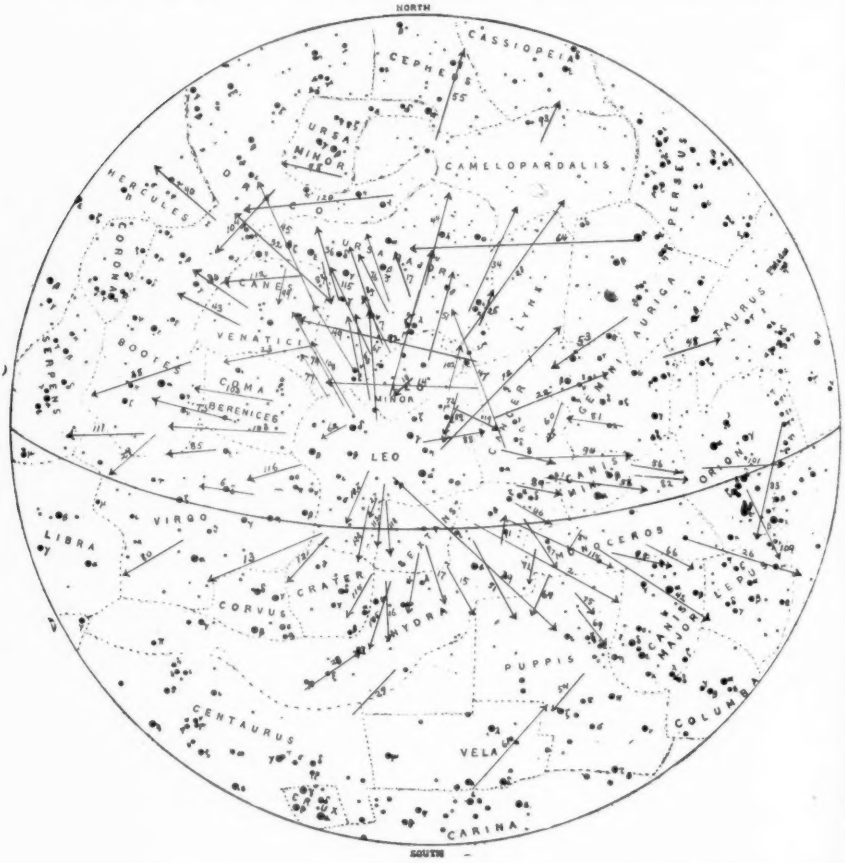
LEONIDS CHARTED AT THE UNIVERSITY OF MINNESOTA, NOV. 14, 1901.

iant, but all meteors seen by the observer were counted. On Nov. 15 two persons were on watch from 12:45 to 16:00, so that almost twice as great a portion of the sky was under scrutiny as on the preceding night. During the rest of the night there was only one as before.

The time at which each meteor appeared was recorded by means of a telegraph wire running out from the Observatory. On account of obstructions in

the eastern sky and the milky horizon due to general sky illumation from the city lights, nothing could be done until about 12:30.

We endeavored, at first, to observe the position, time, class, magnitude and color of each meteor. But when they began to come in great numbers this program had to be abandoned. The estimates of color were unsatisfactory, each ob-



LEONIDS CHARTED AT THE UNIVERSITY OF MINNESOTA, NOV. 15, 1901.

server having a favorite color for the meteors he observed. So this estimate was dropped. Many meteors were seen which left persistent trails, but no time could be devoted to their study.

The position of the radiant point from the map of Nov. 14 is close to the accepted place. But on the following map it seems much farther to the east and the meteors are more scattered. The positions of the second map were observed with more care, and ought to be more accurate than those of the first night.

The observers were C. H. Benson, K. Burns, H. Delaker, R. Y. Ferner, and F. P. Leavenworth.

The result of the count is as follows:

Date 1901.	Minneapolis Mean Time.	Leonids.	Total.	Date 1901.	Minneapolis Mean Time.	Leonids.	Total.
Nov. 13	12:20—12:35	2	2	Nov. 16	13:10—13:20	3	5
	15:30—15:45	2	2		14:00—14:08	0	0
Nov. 14	12:35—13:00	5	5	Nov. 15	12:45—13:00	5	5
	13:00—13:30	8	9		13:00—13:30	10	13
	13:30—14:00	11	13		13:30—14:00	18	23
	14:00—14:30	25	29		14:00—14:30	19	22
	14:30—15:00	29	32		14:30—15:00	16	22
	15:00—15:30	26	31		15:00—15:30	22	29
	15:30—16:00	36	40		15:30—16:00	15	20
	16:00—16:30	50	50		16:00—16:30	7	9
	16:30—17:00	56	56		16:30—17:00	12	14
	17:00—17:30	82	82		17:00—17:07	11	1
	17:40—17:54	50	50				
Total		378	397			128	163

List of Individual Meteors which Appear on the Map for Nov. 14.

Map No.	Minneapolis M. T. h m s	Mag.	Map No.	Minneapolis M. T. h m s	Mag.	Map No.	Minneapolis M. T. h m s	Mag.
1	12 35 26	3	57	14 38 26	4	104	15 43 34	2
2	39 45	3	59	40 18	3	105	44 1	4
5	12 57 52	2	60	40 56	2	106	45 30	2
8	13 4 13	3	61	42 28	2	109	47 18	1
9	5 16	3	62	43 36	5	110*	47 52	{4
10	5 49		63	44 56	3			{2
11	13 3	2	64	47 25	3	112	49 4	3
15	32 41	2	65	48 36	3	113	50 31	3
16	35 21	2	66	49 57	2	114	50 45	4
17	38 55	1	67	50 19	3	116	52 43	
18	40 10	4	68	53 56	3	119	55 6	
19	43 50	4	69	54 58	5	121	55 58	3
21	50 2	4	72	57 34	−2	122	56 20	2
23	55 16	2	74	58 20	3	123	56 23	4
24	13 58 11		75*	14 58 35	4	124	15 57 13	1
25	14 1 38		76	15 0 14	1	126	16 0 0	3
27	5 51	4	77	0 15	1	128	1 37	
28*	5 53	4	79	2 43	5	129	2 17	
32	7 52	1	80	6 54	3	130	2 28	−1
33	8 7	3	81	8 3	4	132	4 1	2
34	9 40	2	82	10 14	2	133	4 52	3
35	9 53	1	83	10 37	1	134	5 48	4
36	10 8	3	85	11 16	2	141	10 28	
37	12 35	2	86	12 55	2	144	11 25	
40	20 58	4	87	14 20	4	146	13 15	1
41	22 14	4	88	15 5	5	149	14 6	0
42	23 4	0	89	17 18		154	15 5	4
43	23 48	1	90	17 53	2	155	15 50	4
44	25 18	4	91	18 21	3	156	18 3	3
45	25 43	4	92	19 39	4	159	19 34	2
46	26 42	4	93	20 19	4	160	20 36	1
47	27 17	5	97	29 38	2	161	23 43	3
48	28 52	3	98	31 29	3	162	23 48	3
49	30 14	2	99	31 30	3	163	24 56	4
50	30 22	2	100	39 20	2	164	25 2	4
51	30 27	4	101	40 10	4	167	26 20	
52	30 41	3	102	42 6		168	27 14	
54*	14 34 19	4	103	15 43 17	3	172	16 27 57	2

Map No.	Minneapolis M. T. h m s	Mag.	Map No.	Minneapolis M. T. h m s	Mag.	Map No.	Minneapolis M. T. h m s	Mag.
178	16 33 5	3	203	16 44 5		230	17 1 58	0
181	34 24	2	204	45 1		233	2 26	0
182	34 41	2	205	45 5		240	4 50	−3
185	38 18		209	48 9	−1	251	9 6	
186	38 23		211	49 26	3	252	9 21	
192	40 24	2	215	51 55		256	10 36	
194	41 15	0	217	54 1	−1	257	11 14	0
196	41 55		225	16 59 18		264	14 35	0
202	16 44 2		229	17 1 39	1	265	17 15 8	

List of Individual Meteors which Appear on Map for Nov. 15, 1901.

2	13 4 53	2	47	14 29 35	4	88	15 30 49	3
3	7 45		48	30 4	4	89	35 54	
4	10 17	4	49	34 1	3	91	38 5	3
6	11 25	4	50	34 7	4	92	" "	
7	12 43	4	51*	34 24	4	93	40 12	5
8	23 2	3	52	38 13	5	94	40 17	2
12	30 55	2	53	40 16	5	95	40 52	4
13**	34 4	3	54	50 37	5	97	42 40	4
14**	32 11	3	55	51 20	3	98	46 30	4
15**	37 36		56	51 48	4	99	51 19	
16	36 54		58	53 0		100	52 57	
17*	36 55		60	57 14		101	53 30	
18	39 33		61	57 25		102	15 56 11	5
21	46 37	4	62	57 33	6	103	16 2 8	1
22	47 30	2	64*	14 58 34	1	104	4 33	2
23	49 39	4	66	15 1 2	5	105	8 12	4
25	52 37	5	67	3 56		107	12 35	2
26	55 59	3	68	4 17		108	14 54	3
27	56 56	5	69	4 54	3	109	26 27	5
28	59 6	5	71	7 1	4	111	38 14	2
29*	13 59 20	5	72	8 2	4	112	38 34	5
30	14 0 26	1	73	9 29	5	113	39 16	3
32	2 25	−1	74	12 30	3	114	43 4	4
34	2 54		75	15 15	4	115	43 37	3
36	6 0		76	16 51	3	116	50 17	3
38	8 24		77	18 3	5	117	52 30	2
39	8 48	1	80	22 59	2	118	52 57	4
40	9 57		81	25 20	4	119	53 47	5
42	20 24	3	82	27 22	4	120	16 56 4	3
43	21 25	2	83	27 40	1	121	17 1 47	2
44	25 1	2	84	28 33	4	122	17 7 19	2
45	25 47	2	85*	28 47	4			
46	14 28 18	5	87	15 30 31	5			

* Two trails with same number.

** Two of these times have wrong minute.

F. P. LEAVENWORTH.

Minneapolis, Jan. 24, 1902.

Leonids Counted at Mt. Pleasant, Iowa, Iowa Wesleyan University.—Thursday night, Nov. 14, 1901: Not expecting more than enough to illustrate to the class their character and habits, work did not begin until 2:30 in the morning.

In numbers they were seen as follows:

From	2:30	to	3:00,	No. seen	was..... 68
"	3:00	"	4:00	"	" 265
"	4:05	"	5:15	"	" 270
"	5:25	"	6:00	"	" 55
				Total	658

At least 150 were seen by the students on the campus before my arrival. The above count was made by 11 persons, myself and members of the astronomy class for the most part. Two of interest are noted on the chart. The one seen by Mr. C. E. Williams which lasted at least 4 min. was very interesting. The last part of the trail spread out like fiery smoke in the region of α and β Ursæ Majoris. The average shooting star was as bright as a star of 1½ mag. and many of them of a negative No. brightness. They were swift and beautiful, most of them visible for many degrees. Up to 5:15 the sky was divided into four parts; after that but two of us did the observing.

Friday night, Nov. 15, 1901: The following Nos. were observed:

1:30—2:30	60
2:30—3:30	93
3:30—4:30	97
4:30—5:45	73
Total	323

One visible for 70 sec. is noted on chart.

The meteors were not so bright, nor so frequent.

These were counted by myself and 14 students. F. W. HANAWALT.

Leonids at Pomona College, Claremont, California.—Volunteers from the astronomy classes of Pomona College maintained a systematic watch for the November meteors again this year. From a study of the current literature on the subject and the results for the past three years, a genuine shower was not expected but it was thought that a considerable number might be seen and that a knowledge of this number, be it large or small, would be of some value in the endeavor to determine more definitely the course and extent of the swarm.

The mornings of the 14th, 15th and 16th from midnight until daylight were divided into half-hour periods and two or more observers were held responsible for each period. During this time the sky was thoroughly watched and results tabulated. An occasional survey of the sky was made on several mornings before the 14th and after the 16th, but no meteors were seen.

No photographic work was undertaken and little mapping done as most of the observers were not sufficiently familiar with the constellations. Only a small portion of those seen on the 15th could have been mapped on account of their frequency.

But the time of appearance of every meteor seen was noted together with such individual description as was possible.

The results are exhibited in two tables. Table I* contains the individual description of all the meteors seen—nearly 1600. This includes *designation*, group and number; *location*, constellation, direction and length; *time* of appearance with duration; and *description*, magnitude, color and notes. In many instances only the time could be given on account of the frequency. The constellation in which a meteor appeared and the direction angle were often omitted.

Table II contains the results by periods, showing the number of meteors seen in each half hour both Leonid and non-Leonid and the time of ten. From this table it will be seen that the thick of the shower came between 3:00 and 5:30 A. M. November 15 reaching its height between 4:30 and 5:00 when 414 were seen in a half hour and the average interval was four seconds. During the latter part of the night the longest interval was less than a minute while several were often seen at once. The least time of ten was 15 seconds—from $4^h\ 0^m\ 15^s$ to $4^h\ 0^m\ 30^s$.

* Omitted on account of its great length.

The climax of the shower is also clearly indicated by the rapid increase in numbers after three o'clock and the large proportion of Leonids.

The magnitudes and depth of color both seemed to vary directly with the frequency. For the greater part of the time less than a quarter of the meteors were of first magnitude or higher, but more than a quarter during the periods of greatest frequency. About half of them were of third magnitude or less. The prevailing color in this half was white, while that of the higher magnitudes was orange, varying from yellow to almost red. A few were called blue or green.

Nearly all were swift as usual. The length of path was usually proportional to the magnitude of the meteor. Many were seen for 20° or 30°, a few from 60° to 90°.

More than a score of meteors were observed whose magnitude, length of path and general appearance were magnificent. Several were seen to burst and scatter; three left trails which were visible for a long time, one of them for about twenty minutes. Among the individual descriptions is the following:

No 92, group IV, Nov. 15 at $1^h\ 31^m\ 35^s$, direction angle 340°, Leonid, blue, of one second duration, length of path 12°, started as a meteor of 4th magnitude, grew larger until it burst. At time of bursting it was half as large as the Moon. It seemed to go all to pieces at once and disappear. Very beautiful.

TABLE II. RESULTS OF OBSERVATION BY PERIODS.

Date. Nov.	Period No.	Time. (A. M. Civil) Begin'g	End	No. Meteors.	No. Leonids	Time of Ten.	Field.	Weather.	Observers.
14	I	12:00	12:30	9	1	——	E & N	clear	Ludden
"	II	12:30	1:00	10	2	$21^m\ 32^s$	"	"	Moles
"	III	1:00	1:30	13	2	——	"	"	Venhuizen
"	IV	1:30	2:00	14	6	19^m	"	"	
"	V	2:00	2:30	13	3	11 24	"	"	Ludden
"	VI	2:30	3:00	7	3	——	"	"	Moles
"	VII	3:00	3:30	10	6	25 17	"	"	"
"	VIII	3:30	4:00	12	3	20 20	"	"	
"	IX	4:00	4:30	18	12	12 36	"	"	Ludden
"	X	4:30	5:00	12	8	15 46	"	"	Moles
"	XI	5:00	5:30	19	11	13 4	"	"	Bent
15	I	12:00	12:30	24	19	11 7	East	"	Reynolds
"	II	12:30	1:00	27	27	8 26	"	"	Venhuizen
"	III	1:00	1:30	37	29	6 46	"	"	
"	IV	1:30	2:00	48	48	6 2	"	"	
"	V	2:00	2:30	66	66	3 50	"	"	
"	VI	2:30	3:00	29	22	7 3	"	"	
"	VII	3:00	3:30	88	88	1 8	North	cloudy in east	Miss Craig
"	VIII	3:30	4:00	150	150	41	E & S		" Wolcott
"	IX	4:00	4:30	268	268	15			Venhuizen
"	X	4:30	5:00	414	414	19		clear	Brackett
"	XI	5:00	5:30	303	303	18		"	
16	I	12:00	12:30	5	?			"	Miss Rice
"	II	12:30	1:00	2	?			"	
"	III	1:00	1:30	0		heavy fog after 1:15			

SUMMARY.

Nov. 14	137	meteors	seen	and	recorded.
" 15	1454	"	"	"	"
" 16	5	"	"	"	"
Total	1596	"	"	"	"

NOTES ON TABLE II.

The "Number of Leonids" includes only those *known* to be Leonids and is probably much too small especially on the 14th.

The number of meteors seen during Period VI Nov. 15 is doubtless smaller than it would otherwise be on account of the haziness of the air, although, whether accidently or not, the number of the corresponding period on the 14th is also the least on that date.

F. P. BRACKETT.

Sunspot Observations, 1900-1901.

1900 Month	No. of Obs.	N. of Equator No. Gr'ps.	Av. Lat. °	S. of Equator No. Gr'ps.	Av. Lat. °	Av. No. at Each Obs.
Jan.	8	2	7½	3	7¾	1.25
Feb.	6	1	9	2*	6½	0.67
Mar.	10	1	½	1	11	1.00
April	7	1	3	2*	12	1.00
May	18	2	4½	2	6¾	0.83
June	13	1*	7	1	2	0.31
Sept.	10	0	.....	0	.....	0.00
Oct.	11	0	.....	2	6½	0.74
Nov.	9	0	.....	1	9	0.22
Dec.	5	0	.....	0	.....	0.00
Total.....	97	7		12		

Average number visible at each observation..... 0.62
Average latitude of spots N. of equator..... + 6°.4
Average latitude of spots S. of equator..... — 8°.0

1901 Month.	No. of Obs.	N. of Equator No. Gr'ps.	Av. Lat. °	S. of Equator No. Gr'ps.	Av. Lat. °	Av. No. at Each Obs.
Jan.	5	0	.....	0	.....	0.00
Feb.	11	1	2	0	.....	0.28
Mar.	9	2	2½	0	.....	0.67
Apr.	5	0	.....	0	.....	0.00
May	13	1	5	0	.....	0.31
June	8	2*	15¼	0	.....	0.25
Sept.	8	0	.....	0	.....	0.00
Oct.	18	0	.....	2	8½	0.33
Nov.	13	0	.....	2*	13½	0.54
Dec.	7	0	.....	0	.....	0.00
Total.....	97	5		3		

Average number visible at each observation..... 0 31
Average latitude of spots N. of equator..... + 7°.2
Average latitude of spots S. of equator..... — 13°.2

Observations were made by projecting an image of the Sun upon a screen attached to the 8-inch equatorial telescope. Latitudes were obtained with the aid of Thomson's discs, and are only approximate. No record was kept during college vacations, so that July and August are omitted from the report.

June 3d, 1901, a tiny spot was seen in N. lat. 23°; Nov. 15th a well defined group was seen in S. lat. 22½°. With these exceptions all spots observed were within 13° of the equator.

ANNE SEWELL YOUNG.

MT. HOLYOKE COLLEGE.

* One of these is included in the number for the preceding month.

The Astronomical Theory of the Ice Age.—There has come to hand recently a publication by C. V. L. Charlier of the Lund Astronomical Observatory, titled contributions to the astronomical theory of the ice age. This paper begins by citing the two main propositions which sum up the opinion of Sir Robert Ball, as expressed in a small book written in 1891, in which the theory by Croll was exposed and reviewed. Those two propositions are as follows:

1. Of the total amount of heat received from the Sun on one hemisphere of the Earth, in the course of a year, 63 per cent is received during the summer, and 37 per cent is received during the winter.

2. The only agent that alters the climatic conditions of the season, from an astronomical point of view, is the difference between the length of the summer-half and the winter-half of the year.

The author of this paper supports the view of Sir Robert Ball, and discusses the amount of heat the Earth receives from the Sun, the length of the seasons of the Earth and the approximate calculation of the difference between the length of the summer and the winter, by considering the secular variations of e and π. In this part of the paper he uses results obtained from formulæ by Stockwell and Leverrier, and the calculations of McFarland in 1880 in *The American Journal of Science*. The author uses his values of e and π from year $-$ 300,000 to year $+$ 100,000. He also adds some paragraphs relating to the planet Mars. The schematic diagrams representing the difference between the length of the summer and winter half-years are neatly drawn and show important results.

Annals of the Toulouse Observatory.—Volume IV. of the *Annals of the Observatory of Toulouse* is a splendidly printed volume of over 500 quarto pages and contains the detailed results of meridian circle observations from 1891 to 1900, by M. Saint-Blancat, adjunct astronomer, under the direction of M. B. Baillaud, Director of the Observatory. The final catalogue of stars contains the right ascensions and declinations, for the epoch 1900, of 3917 stars, most of them included in the zone from 5° to 10° of north declination.

Lick Observatory.—*Bulletin* No. 13 of Lick Observatory contains the results of the micrometrical observations of Eros, made with the 36-inch refractor by W. J. Hussey and R. G. Aitken. This is a fine series of measures and should be of great value in the solution of the parallax problem. The bulletin contains also a list of the approximate places of the comparison stars, and a list of the photographs of Eros which were taken by C. D. Perrine, assisted by H. K. Palmer, with the Crossley reflector. The total number of plates is 965, of which 854 are of short exposures for measurement, and contain over 4,000 images of the asteroid.

Flammarion's "Annuaire Astronomique," 1902.—This little volume contains a great quantity of matter, much of which is valuable to the amateur astronomer, and is presented in convenient form. There are tables of the rising and setting of the Sun and Moon for each day of the year, refraction, eclipses, occultations, maps of the courses of the planets, constellation charts for each month, diagrams for finding the positions of sunspots, the minor planets arranged in the order of distances and periods, parallaxes and distances of the stars, proper motions of the stars, orbits of double stars, orbits of periodic comets, meteor charts, reviews of the principal astronomical discoveries during the past year, and many other interesting matters. The price is 1 fr. 25.